COMPUTER FORM 4 NOTES

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COMPUTER STUDIES NOTES

FORM 4

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By *Sir Obiero Amos Resources*

INTRODUCTION TO NETWORKING AND DATA COMMUNICATION
INTRODUCTION
A computer network forms whenever 2 or more computers are interconnected together with other related accessories to work together.
Non computer networks include:o00hgtr56hig
a) Road networks that facilitate transfer of goods and services.
b) Telephone networks (voice networks) with many lines that criss cross a country.
c) Blood circulatory system in the human body.
d) The neuron system in the human brain.

DEFINITION OF TERMS USED IN NETWORKING
**1. COMPUTER NETWORK**

- A collection of independent entities that are arranged in such a manner as to exchange data, information or resources.
- A collection of computers linked together using transmission media for the purpose of communication and resource sharing.

2. TRANSMISSION MEDIA

- Transmission media refers to any physical or non-physical link between two or more computers and in which a signal can be made to flow from source to destination.
- Some of the shared resources include:
  a) Application programs.
  b) Printers.
  c) Fax machines.
  d) Modems.
  e) Storage devices.

3. DATA COMMUNICATION

- It is the process of transmitting data signal from one point to another through the network.
- It is the movement of data by telecommunication systems.

Sender		Receiver
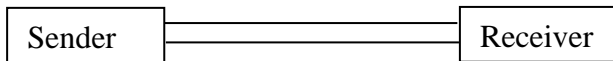
TERMS USED IN DATA COMMUNICATION

1. Data signal.
2. Signal modulation and demodulation.
3. Multiplexing.
4. Band width.
5. Base band.
6. Broad band transmission.
7. Attenuation.

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1. DATA SIGNAL

- Computers communicate by transferring data signals between themselves.
- Refers to a voltage level in the circuit which represents the flow of data.
- There are two types of data signals:
  a) **Analog signal**: data made up of continuous varying wave form similar to voice or sound wave.
  b) **Digital signal**: data made up non-continuous discrete signal.

2. SIGNAL MODULATION AND DEMODULATION

- Process of converting data signals to a form that is suitable for transmission over a transmission medium.
  a) **Modulation**: converting digital data signals into analog data signals.
  b) **Demodulation**: converting digital data by superimposing it on analog carrier signal which can be transmitted over analog telephone lines.

3. MULTIPLEXING

- Process of sending multiple data signals over the same medium i.e. a wire conductor can be made to carry several data signals either simultaneously or at different times.
- Demultiplexing is the process of separating the multiplexed signals at the receiving end.
- The different data signals are made to have different frequencies on the cable hence they do not interfere with one another.
- The different frequencies cause what is called different logical channels in the medium.
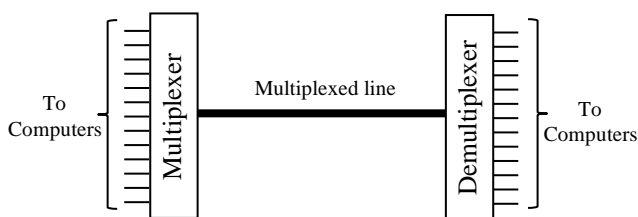
A multiplexed link

- 4 -

4. BAND WIDTH

- The maximum amount of data that a transmission medium can carry at any one time. For example, a certain cable may have a bandwidth of 100 Mbps (Mega bits per second).

5. BASE BAND SIGNAL

- A signal that is generated and applied to the transmission medium directly without modulation.
- The signal takes the form of voltages of different magnitudes applied to the medium.

6. BROAD BAND TRANSMISSION

- This is where an analog signal is send over the transmission medium using a particular frequency.
- Several data signals can be send simultaneously through the same medium but at different frequencies.

7. ATTENUATION

a) This is the loss of signal strength (decrease in magnitude and energy) as a signal progressively moves along a transmission medium.
b) If the signal is not boosted, it will totally be lost along the way and may never reach the destination.
c) This condition is usually corrected by placing signal amplifiers also called repeater stations along the medium at appropriate distances in order to receive the weak signal, clean it, amplify it then retransmit it.
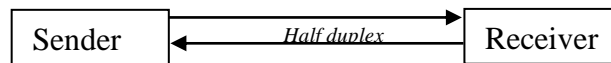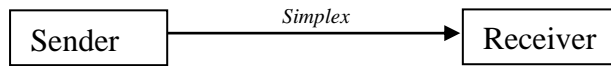
MODES OF DATA COMMUNICATION

1. Simplex.
2. Half duplex.
3. Full duplex.

1. SIMPLEX

- Communication is only in one direction.
- They re only meant to send or receive messages.

Example

a) Radio broadcast – the listener cannot communicate back through the radio receiver.
b) Television broadcast.
c) Transmission from a computer to a line printer.

| Sender | —— *Simplex* ——→ | Receiver |

| Sender | ←—— *Half duplex* ——→ | Receiver |

2. HALF DUPLEX

- Communication takes place in both directions but one direction at a time.
- Two interconnected devices exchange data alternately where the devices switch between send and receive modes after each transmission.

Example

1. Walkie talkies
2. Fax machines.
3. Modems.

3. FULL DUPLEX

- Occurs in both directions simultaneously.

| Sender | ⇄ *Full duplex* ⇄ | Receiver |
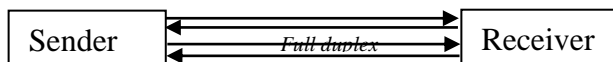
Example:

a) Telephone system, a person can talk without waiting for the other to finish.

b) Computers can send and receive data on a network.

TYPES OF COMPUTER NETWORKS

1. Local Area Networks (LAN) *Classified according to size.*
2. Metropolitan Area Network (MAN)
3. Wide Area Network (WAN)

1. LOCAL AREA NETWORK

- A communication network that spans a relatively small geographical area like in one building or a school.
- LANs are characterized by:
a) Limited geographical area.
b) High data transmission rates.
c) Low cost transmission
d) Low intra-office traffic.

- LANs allow information and computer resources to be shared by many users e.g.
a) Mass storage devices.
b) Processors.
c) Printers.
d) Plotters.
e) Software.

- LANs are also characterized by the following components:
a) Server.
b) Work stations.
c) Network interface cards (NIC)
d) Network transmission cables.
e) Network operating systems.
f) Network accessories.

A. SERVER

- A computer dedicated to servicing requests for resources from other computers (workstations) on a network.

- The server provides services to LAN users.

B. WORK STATIONS
- Any other computer connected to a network and can share resources with any other devices on the network.

2. METROPOLITAN AREA NETWORK (MAN)
- Type of a network which covers a geographical extended fashion area like a town or city (approximately a radius of 5 – 50 km).
- The MAN infrastructure may be owned by a single company that has offices across a metropolitan area.
- A MAN therefore is made up of many LANs in a metropolitan area.

3. WIDE AREA NETWORK (WAN)
- Also known as Long Haul Network (LHN).
- It is a type of a network that covers a large geographical area such as a country, a continent or the whole world.
- It consists of many LANs and Mans connected to form one large network such as the Internet.

CHARACTERISTICS OF WANs
a) Unlimited geographical area.
b) Low data transmission rates.
c) High transmission link costs.
d) Long distance transmission.
e) High degree of vender independence.
f) Costly to install and maintain.

PURPOSE AND LIMITATIONS OF NETWORKING
- These are the reasons for setting up computer networks, together with the challenges associated with the implementation of the computer networks.

PURPOSE OF NETWORKING
1. Resource sharing
2. Remote communication.

3. Distributed processing facilities.
4. Cost effectiveness.
5. Reliability.

1. Resource sharing

- Resource refers to data/information, files, printers, modems, communication links, storage devices, fax machines, application programs etc.
- As long as computers are connected, they can share their files, exchange mail, send faxes from any point on the network.
- Users do not need to transfer files via removable storage but would send the work to a network printer.
- The centralized access to data and information leads to less waste of time and hence greater productivity.
- In most network arrangements, the shared resources may be attached to a network server.
- The clients/workstations then send their requests to the server.
- The network server runs a special program (server software) which controls computers on the network and listen to client requests to service them over the network. – Illustration Page 6

2. Remote communication

- Refers to the transmission of data signals between the communicating devices located at different geographical locations.
- A remote client (a computer that accesses resources) from a remote host (the computer being accessed) provides remote communication mostly by use of wireless transmission media such as radio waves, microwaves and satellites.
- It is through remote communication that people can be able to share ideas and pass messages over the Internet.
- Remote communication thus eliminates the need of people to travel/roam for long distances by giving them a lot of freedom to the network which translates to more productivity.

3. Distributed processing facilities

- Refers to the act of running the same programs or databases on different computers which are on the same network.
- Computers can do processing at their own dispersed locations or departments and can share programs, data and other resources with each other.
- It simplifies flow of information and saves time and resources.

Advantages of distributed data processing:
a) The failure of the central computer does not affect the operations of the other terminals.
b) Processing load is shared equally hence no time wastage.

4. Cost effectiveness
- Although the initial cost and laying down of network components may be expensive, the savings experienced and the value added to service delivery make them a ready choice for enterprising managers.
- The network greatly increases the efficient use of scarce resources.
- Networks have also enhanced daily communication by providing a paperless communication environment.
- Users can send electronic messages and mail to each other instead of having to bear the cost of stamp duty or delivery charges.
- Company executives may not need to travel across continents to hold meetings. They can hold video conferences and save on traveling expenses.

5. Reliability
- Data can be transferred with minimum error from source to destination.
- Users can still access data and information from the other computers on the network incase one breaks down.

LIMITATIONS OF NETWORKING

1. Security issues.
2. High initial cost.
3. Moral and cultural effects.
4. Spread of terrorism and drug trafficking.
5. Over-reliance on networks.

1. Security issues

- Data and information is prone to more illegal access threats because there can be data access and sharing from various points.
- Data can also be tapped or listened to by unauthorized parties, during transmission of data from source to destination.
- One of the common methods of data protection in a networked environment is encryptioning.

2. High initial cost

- Networking is an expensive venture for an organization.
- It is expensive to acquire networking equipments.
- It is expensive to train network administrators, users and general maintenance of networks.
- The initial cost of buying network hardware and software is very high.

3. Moral and cultural effects

- The internet has chat rooms and messaging services that may enable under age children to meet peers and adults on the net, some of whom may have bad intentions.
- Access to pornography and other negative materials has also led to moral decay, leading to the fight against social problems like HIV/AIDS, bad sexual behaviour, drugs and substance abuse more complicated.

4. Spread of terrorism and drug trafficking

- The internet provides a rich recruitment ground for all types of illegal activities such as terrorism and drug trafficking.

- The easy flow of information from one place to another keeps even those who are on the wrong side of the law communicating easily.
- Terrorists and drug traffickers use information networks for their business communications.

5. Over-reliance on networks
- The danger of network failure can paralyze the operations of an organization besides damaging files.
- If by any chance the network fails, many systems in organizations can be brought to a halt.

ELEMENTS OF NETWORKING
A computer network is made up of several standard elements (components) which can be classified into 3 major categories:
1. Data communication media.
2. Communication devices.
3. Networking software.
4. Data signal.

1. DATA COMMUNICATION MEDIA
- A pathway used for carrying data and information from one point to another.
- The communication medium dictates the type of signals that will be used to transmit a message.
- Transmission media is the physical path (bounded) and non physical path (unbounded) between the transmitter and the receiver.
- The communication media/channels/pathways can be divided into two:
a) Communication using cables (bounded media).
b) Wireless communications (unbounded media).

A. COMMUNICATION USING CABLES (BOUNDED MEDIA)
- Communication signals are transmitted from the source to the destination through a restricted pathway such as a cable.
- Any radiation from the guided medium is regarded as signal loss.
- The most common types of bounded transmission media are:

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i) Two wire open line cables.
ii) Twisted pair cables.
iii) Coaxial cables.
iv) Fibre optic cables.

I) TWO WIRE OPEN LINES CABLES:

- Made up of two parallel copper wires separated by a plastic insulator.
- Used in telecommunication network to transmit voice signal.
- Although the plastic insulator is meant to reduce inter-line interference called crosstalk, their linear nature allows an electromagnetic field to build around them during heavy data transmission which may cause interference to the signal.
- The wires also capture environmental frequencies e.g. radio waves hence causing noise in the transmission channel.
- Noise refers to random unwanted signals picked up by the channel.

Two wire open lines cables
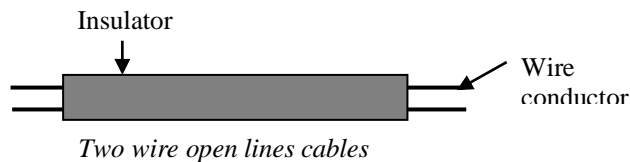
- The most significant impairments during data transmissions are:
a) Attenuation: the loss of signal strength (amplitude) as is travels along the cable.
b) Cross talk: caused by signal coupling between the different cable pairs contained within a multipair cable bundle i.e. interline interference.
c) Noise: Random unwanted signals picked up by the channel, caused by either cross talk or externally included impulses e.g. from sources like motors, switching equipments, high current equipments etc.
d) Impendence: this is the resistance offered by the cable to the signal.

II) TWISTED PAIR CABLES

- Made up of two solid copper wire strands wound around each other in a double helix manner to reduce the development of an electromagnetic field around the two wires as they transmit data.
- Mostly used to transmit both voice and data signals.
- The two common types of twisted pair cables are:
  - a) The unshielded twisted pair (UTP)
  - b) Shielded twisted pair (STP)

a) Unshielded Twisted Pair (UTP)

- a) They do not have a shield that prevents electromagnetic interference (EMI) also called (electric noise" from the environment like lightening sparks, radio signals and radiations from spark plugs in motor vehicles.
- b) They are therefore not suitable for environments that are electrically " noisy" .

b) Shielded Twisted Pair (STP)

- Similar to unshielded twisted pair except that a braided shield is wrapped around the wires to protect (shield) them from noise.
- The shielding may be a metallic foil or copper braid.
- Shielding minimizes electromagnetic interference (EMI) or radio frequency interference.
- Twisted pair cables are categorized into 5 groups according to the type of data transmitted and maximum rate of transmission as shown below:

Category	Suitable for transmitting	Speed (max. limit)
1	Voice	Less than 1 Mbps
2	Data	1 Mbps
3	Data	16 Mbps
4	Data	20 Mbps
5	Data	100 Mbps

KEY:

- Mbps – Megabits per second.

- Today's networks are approaching speeds of Gigabits per second.
- Most organizations today use category 5 twisted pair cables to set up their local area network.

Advantages of twisted pair cables:

a) They can support high data rates (bandwidth) of up to 100 Mbps.

b) Telephone systems use UTP which is present in most buildings hence it is easier to set up a network media because connection is already available.

c) Installation equipment is cheap and readily available.

d) It is cheap because of mass production for telephone use.

Disadvantages of twisted pair cabling

a) Suffers high attenuation – a repeater is needed to amplify the signal.

b) It is sensitive to electromagnetic interference and eavesdropping (tapping into communication channels to get information).

c) It has low data transmission rates as compared to other cables.

III) COAXIAL CABLES

- Specially wrapped and insulated cables that are able to transmit data at very high rate.
- They consist of central copper wire covered with a dielectric material (insulator).
- The dielectric material is then surrounded by a hollow mesh conductor which is covered by a shield making the cable more resistant to electromagnetic interference than the twisted pair cable.
- The signal is transmitted by inner copper wire and is electrically shielded by the other copper sleeve.
- The braid (mesh conductor) is made up of copper or aluminum and serves as the ground for the carrier wire.
- Together with the insulation and any foil shield, the braid shield protects the carrier wire from radio frequency interference (RFI) and electromagnetic interference (EMI).
- Although the cable has better protection against electrical interference than the TCP, they have moderate protection against magnetic interference.

- The diameter of the centre core or conductor determines the attenuation rate i.e. the thinner the core, the higher the attenuation rate.
- Data is carried on this cable using direct current (DC).
- Coaxial cables have bandwidths of up to 1Gbps, hence they are installed in a network to form the network backbone (a link that connects two or more separate local area networks).
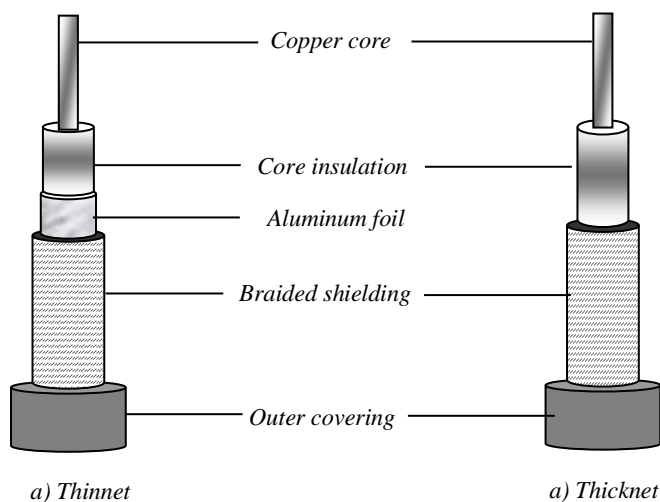
Types of coaxial cables:

a) Thin coaxial cable (Thinnet)

- Has one dielectric insulator.

b) Thick coaxial cable (Thicknet)

- Has two dielectric insulators around the core and is thicker than the thinnet.

Copper core

Core insulation

Aluminum foil

Braided shielding

Outer covering

a) Thinnet   *a) Thicknet*
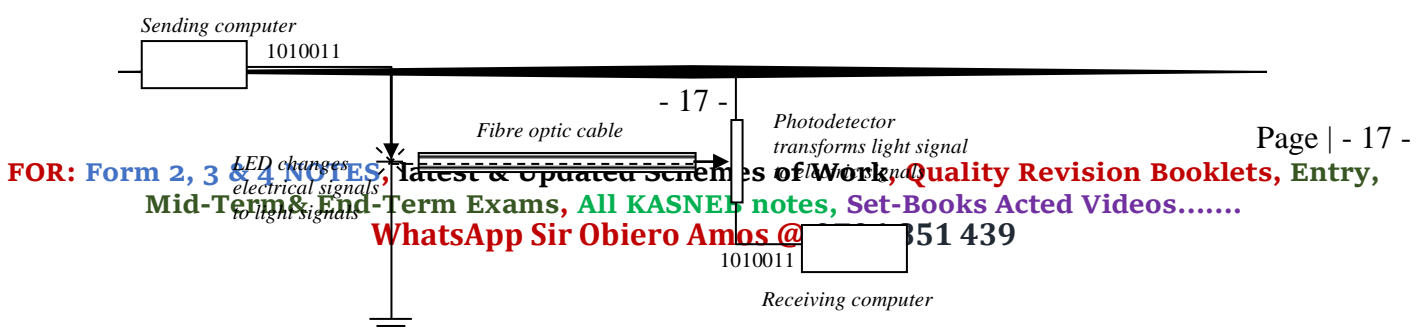
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Advantages of coaxial cables

1. They are very stable even under high load.
2. Have a large bandwidth – up to 1Gbps compared to twisted pair.
3. Can carry voice, data and video signal simultaneously.
4. More resistant to radio and electromagnetic interference than twisted pair cables.
5. Extensively used for longer distance telephone lines and as cables for closed circuit TV.
6. Many are packaged in bundles that can handle 15000 telephone calls simultaneously.
7. Have a higher immunity to noise distortion and data loss.

Disadvantages of coaxial cables

1. Thick coaxial cables are hard to work with.
2. They are relatively expensive to buy and to install as compared to twisted pairs especially for longer distance transmission.
3. They are vulnerable to tapping.
4. Attenuation for long distance transmission.

IV) FIBRE OPTIC CABLES

- Utilize light (optic) to transmit data from one pint to another on the network.
- Electrical signals from the source are converted to light signals, and then propagated along the fibre optic cable.
- To convert an electric signal to light, you need a light emitting diode (LED) at the transmitter.
- At the receiving end, a photosensitive device can be used to convert the light signals back to electric signals that can be processed by the computer.

Sending computer
1010011

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Fibre optic cable

Photodetector transforms light signal

LED changes electrical signals to light signals

1010011

Receiving computer

Fibre network.

Types of fibre optic cables
a) Single mode fibre.
b) Multimode fibre.

a) Single mode fibre
- Has a very narrow center core.
- Light in the cable can only take one path through it.
- Has a low attenuation rate.
- Preferred for long distance transmission.
- Has a bandwidth of 50 Gbps which is higher than that of the twisted pair's 100Mbps.
- It is very expensive.
- Requires very careful handling during installation.

b) Multimode fibre cable
- Has a thicker core.
- Allows several light rays to be fed in the cable at an angle.
- Distortion of signals is possible because of multiple light signals navigating the cable at the same time.
- Have a high attenuation rate.
- Usually used for shorter distances than single mode.

Single mode fibre

Multimode fibre
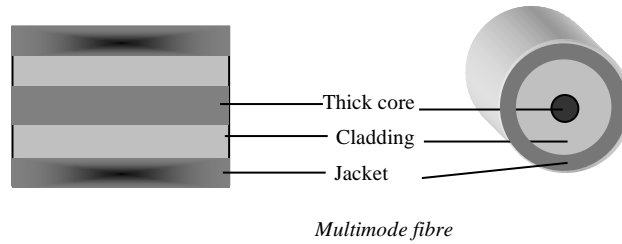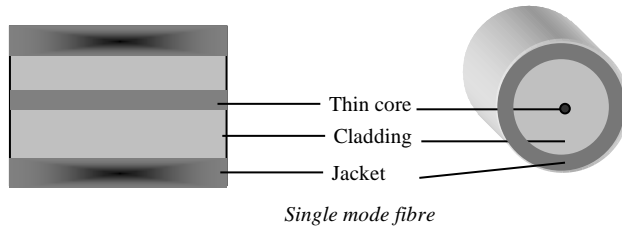
- Light signal travels through the core through a process referred to as total internal reflection.
- The process that causes total internal reflection is called refraction.
- Refraction is the bending of light when it crosses the boundary of two mediums that have different density.
- When light signal is inserted into the cable, it rises to cross from the core to the cladding.
- The light is bent back into the core hence propagates along the length of the cable as shown below:

Light rays

Multimode fibre   *Cladding*
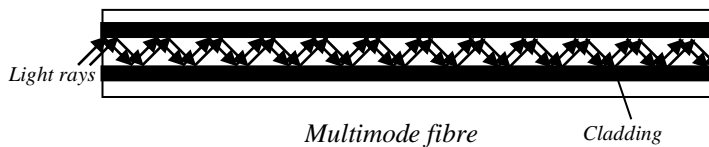
The fibre optic cable is made up of:
a) The Core.

b) Cladding.
c) Buffer
d) Strength member.
e) Jacket.

a) The core:

- The central part of the cable made of a hollow transparent plastic glass.

b) Cladding:

- a single protective layer surrounding the core. It has light bending characteristics.
- When light tries to travel from the core to the cladding, it is redirected back to the core.

c) Buffer:

- Surrounds the cladding and its main function is to strengthen the cable.

d) Jacket:

- It is the outer covering of the cable.

Advantages and features of fibre optic cables
1. Offer high quality transmission of signals.
2. Light weight – a normal glass fibre is the size of a human hair.
3. Can transmit voice, data and video signals simultaneously.
4. Have a large bandwidth (up to 1Gbps).
5. Low cross talk.
6. Immune to interference and eavesdropping.
7. More resistant to radio and electromagnetic interference.
8. Long distance can be covered because they have low attenuation.
9. Can be used in hazardous places – high flammable, because the do not generate electrical signals.
10. Can withstand extreme temperatures – up to 1000^0C.

Disadvantages of fibre optic

1. Connectivity devices and the media are expensive.
2. Installation is difficult because the cable needs careful handling.
3. Relatively complex to configure.
4. A broken cable is difficult and expensive to repair.
5. Expensive for shorter distances.
6. Prone to water seepage and freezing.

B. WIRELESS COMMUNICATION (UNBOUNDED MEDIA)

- Type of media used to transmit data from one point to another without using physical connections.
- A transmitting antenna and receiver aerial are used to facilitate the communication.

Examples of wireless transmission media:
i) Microwaves.
ii) Satellite.
iii) Radio waves.
iv) Infrared transmission.
v) Bluetooth technology.

- The transmission media above use different frequencies of the electromagnetic spectrum as shown below.

10^{22}Hz	Gamma rays
10^{20}Hz	X - Rays
10^{16}Hz	Ultra-violet (UV)
10^{15}Hz	Visible light
10^{13}Hz	Infra-red (IR)
10^{10}Hz	Microwaves
10^{8}Hz	UHF
10^{7}Hz	VHF
10^{6}Hz	HF

Frequency increases

Wavelength increases

Radio waves
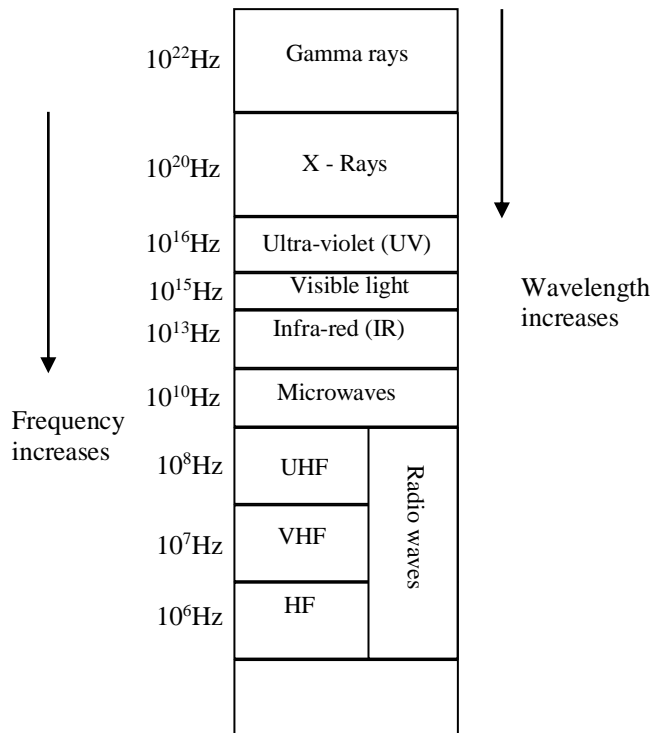
The electromagnetic spectrum

I) MICROWAVE TRANSMISSION

- A microwave is extremely high frequency (communication beam) that is transmitted over direct line of sight path.
- The method uses very high frequency radio signals to transmit data through space.
- The electromagnetic wave cannot pass obstacles and geographical barriers such as mountains.
- Due to their small wavelength, they easily release their energy in water as heat hence they are also used in making microwave ovens used in domestic kitchen appliances.
- In networking, microwaves are suitable for point to point transmissions.
- A signal is directed thorough a focused beam from transmitter to the receiver station.

II) SATELLITE COMMUNICATION

- A satellite is a microwave relay station.
- The microwave stations have parabolic dishes with an antenna fixed on them in order to focus a narrow beam towards the satellite in space.

Main Components of a satellite transmission system

1. Transmitter earth station:
- Sets up an uplink to the satellite in order to transmit data.
- The uplink has a unique frequency.

2. A satellite:

- Launched somewhere in an orbit that receives, amplifies and retransmits the signal to a receiving earth station via a downlink frequency that is different from that of the uplink so as to avoid interference with the uplink signal.

3. Receiving earth station:

- Receives the sent signal on the other side of the globe.

Satellite in space

Uplink

Downlink

Transmitter
earth station

receiving
earth station

Satellite transmission system

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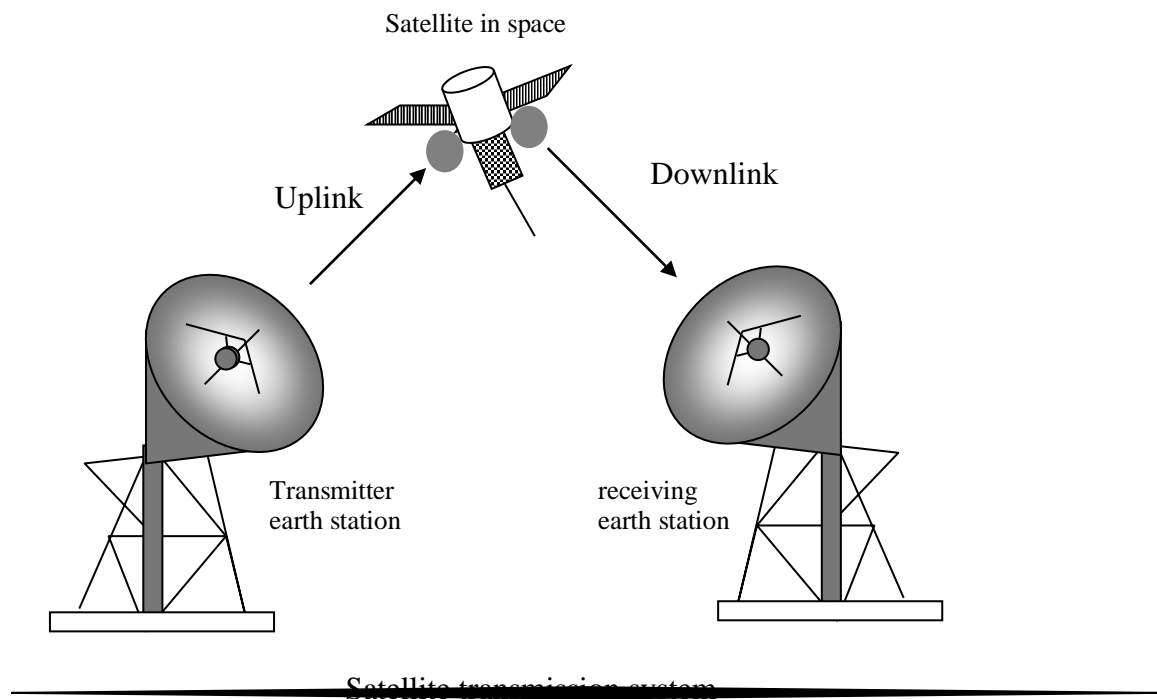
- A communication satellite is usually launched into space about 36,000 km above the earth in such a manner that its speed will be relatively equal to the rotation speed of the earth.
- These types of satellites are called geostationary satellites.
- They are convenient because they eliminate the need to keep on moving the parabolic dish in a bid to track the line of sight.
- A geostationary satellite offers a large constant line of sight to earth stations.
- The area where the line of sight can easily be located is called the satellites footprint.
- The satellite transmits the signal to many recipient earth stations to form a point to multipoint transmission.
- The new trends in microwave transmission have seen the use of very small aperture terminal (VSAT) technology.
- It refers to a very small satellite dish used both in data, radio and TV communication.
- It enables direct communication instead of having to go through the state owned satellite gateways.
- The satellite produces strong signals that can be received by a satellite dish antenna of only about 2 meters in diameter.
- The signals are decoded using a decoder which is plugged directly to a television set or a computer.

III) RADIO COMMUNICATION
- Radio waves travel just like surface water waves.
- They are omnidirectional i.e. they start from a central point and spread outwards in all directions.
- Their energy spreads outwards over the covered area.
- The waves are radiated into the atmosphere by a radio frequency antenna at constant velocity.
- Radio waves are not visible to the human eye.
- They are used in radio and television broadcasts.
- Data can also be transmitted over radiowaves communication channels.

- Radiowaves can be of high frequency, very high frequency or ultra-high frequency.
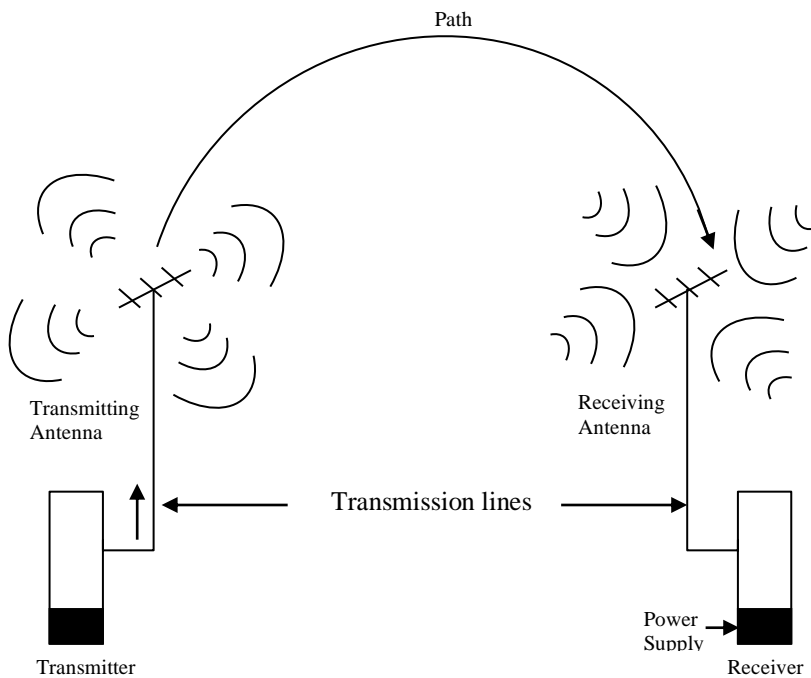
a) High frequency (HF) radio waves
- A Signal is propagated by directing it to the ionosphere of the earth.
- The iron sphere will reflect it back to the earth's surface and the receiver will pick the signal.
- The biggest challenge of HF communication is the danger of signal interception by unauthorized parties.

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HF radio transmission
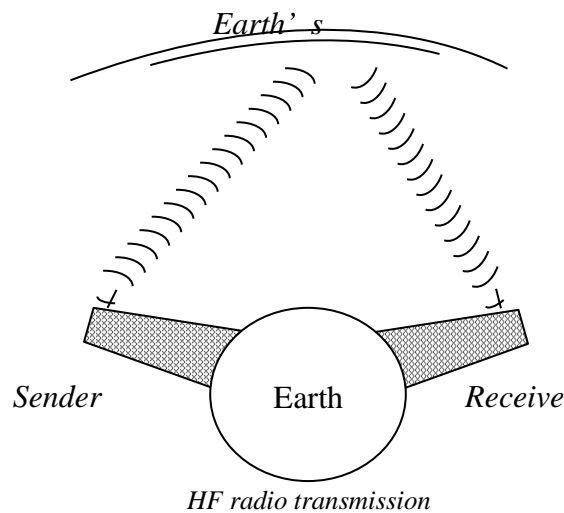
b) Very high frequency (VHF) radio waves

- Transmitted along the earth's surface.
- Due to the curvature of the earth, the signal will most likely attenuate at the horizon.
- Repeater stations have to therefore be placed strategically to maintain a line of sight in order to receive, amplify and propagate the signal from one area to another.
- Common technology with the hand held radio devices like ' walkie-talkie' radios.
- The range of VHF is limited but preferred to high frequency where no major obstructions are encountered on the landscape, because it is possible to make the wave to follow a narrower and more direct path to the receiver.
- To overcome the obstructions on the earth surface like mountains and buildings, repeater stations are built on raised areas.

c) Ultra high frequency (UHF) radiowaves.

- They are like VHF when it comes to the line of sight principle i.e. there should be no barrier between the sending and the receiving aerial.
- They require smaller aerials.
- The TV aerial for VHF is bigger than the one for UHF radiowaves because UHF radiowaves can be made to follow an even narrower and direct path to the receiver than VHF radiowaves.

- Therefore UHF is popular for horizon limited broadcasts.

IV) BLUETOOTH TECHNOLOGY

- A new transmission technology i.e. a short range technology that enables people to use hand held communication devices like cell phones and PDAs to access the internet.
- It enhances communication of personal communication devices through wireless technology.
- The main component in Bluetooth is a small low power two-way radio transceiver, small enough to be inserted in small devices.
- A network of Bluetooth enabled devices is called a wireless personal area network (WPAN) or piconet.

V) INFRARED TRANSMISSION

- Fall just below the visible light on the electromagnetic spectrum.
- They are not visible to the human eye.
- Communication is achieved by having infrared transmitters and receivers (transceivers).
- Transceivers of infrared signals must be within a line of sight in the same room.
- Unlike radio signals, infrared signals cannot penetrate obstacles like walls. However, the signal can be reflected off surfaces like walls and ceiling until they reach their destination.
- An example is the infrared transceiver on most mobile phones.
- Once activated, two people in the same room can send messages to each other on their mobile phones without going through the mobile service provider.
- In computer networking, the technology can be used to connect devices in the same room to each other without need for cables e.g. a computer to a printer.
- The computers infrared transceiver must maintain a line of sight with the one for the printer.

Advantages of wireless communications

1. Wireless medium is flexible in operation as compared to bounded media i.e. devices can be moved around without losing access to the network.
2. Wireless networks can span large geographical areas easily.

3. It can take place via satellite even in very remote areas that do not have high cost physical infrastructure like telephone lines.

Disadvantages of wireless communications
1. Relatively difficult to establish or configure.
2. The initial cost is very high.

COMMUNICATION DEVICES
- These are devices used as interfaces or junctions between the terminal devices.
- Terminal equipment are devices at both ends of the communication link such as a computer.
- Examples of data communication devices include:
    i) NICs.
    ii) Modems and codecs.
    iii)   Hubs.
    iv) Bridges.
    v) Repeaters.
    vi) Routers.
    vii)   Gateways.
    viii)   Switches.
    ix) Access points.

I) NETWORK INTERFACE CARDS (NIC)
- Creates a physical link between the computer and the transmission media.
- It is plugged into an empty expansion slot on the motherboard.
- However, most computer motherboards to day come ready with an onboard network interface controller.

II) MODEMS AND CODECS
- A modem converts a signal from digital to analog form for the purpose of transmission over the analog media.
- A codec converts an analog signal to digital form for transmission via a digital medium.
- A modem can be external, an add-on card or built on the motherboard.

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III) HUBS Illustration pg 24

- Also called a concentrator.
- It is a component that connects computers on a network and is able to relay signals from one computer to another on the same network.
- A hub usually connects networks that have a common architecture i.e. one that has the same set of communication software usually called protocols.
- Protocols are a set of rules that govern the communication between devices on a network.
- A hub transmits signals by broadcasting them to all the components on the network.
- After the signal is broadcasted, the computer whose address is on the message picks the message from the network that is part of the broadcast domain.
- Some hubs called intelligent hubs are able to monitor the way computers are communicating on the network and keep the information in a small database of their own called a management information base (MIB).
- The NT server can then use this information to fine-tune the NT.
- Intelligent hubs can be able to manage a NT by isolating computers that are not functioning properly.
- Several hubs can be connected together one after another to expand a NT. However, this increases the broadcast range which may lead to broadcast storms on the network.
- Broadcast storm refers to a condition where a NT is overwhelmed with message broadcasts due to malfunctioning of NICs or hub related problems.

IV) BRIDGES illustration pg 25.

- NT device that selectively determines the appropriate NT segment for which message is meant for delivery through address filtering.
- A bridge can divide a busy network into segments to reduce network traffic.

Purpose of using a bridge:
1. To extend the length and number of stations that a segment can support.
2. Reduce overall traffic flow by allowing broadcasts only in the data destination segment of the NT.

- A bridge makes sure that packets that are not meant for a particular segment are not broadcasted in that segment.

IV) REPEATERS
- A device that receives a signal from one segment of a NT, cleans it to remove any distortion, boosts it and then sends it to another segment.
- It enables NT to eliminate attenuation problems.
- They are the simplest way to expand a NT because they broadcast the same message to other NT segments.
- However, they should be used with reservation, because they expand the broadcast domain, which may lead to broadcast storms on the NT.
- A broadcast storm is a condition whereby the NT is oversaturated with messages making communication impossible.

V) ROUTERS
- Interconnects different NTs and directs the transfer of data packets from source to destination.
- Routing depends on NT addresses.
- Each NT has a unique identifier or address called the network address.
- All the computers on the same network have the same network address nut different host numbers.
- The router receives a packet from another router on the internetwork and checks the destination's network address.
- If the address is the same as the one on which the router is, it passes the data packet to the destination host by reading the host address otherwise the packet will be routed to the next network address.
- Some modern routing devices combine the functionality of a bridge and a router, called a brouter.

VI) GATEWAYS Illustration pg 27
A gateway is any device that can be configured to provide access to wide area networks or Internet.
One such device is the router in which the gateway software is installed.

A gateway is the most powerful network and internetwork connectivity device because of its ability to convert data across different network architectures and protocols.

VII) SWITCHES Illustration pg 28

- Unlike a hub, a switch forwards a packet directly to the address node without broadcasting.
- A node refers to data terminal equipment such as a workstation or a computer on the network.
- The switch does this by connecting two nodes point to point as if they were linked by a direct cable between them.
- Some hubs also incorporate the switching mechanisms. Such a hub is referred to as a switching hub.
- Switches are more expensive than hubs. This means that one switch may be used as a bridge to connect several hubs in order to reduce collision problems caused by broadcasts.

WIRELESS COMMUNICATION DEVICES

- As the cost of wireless technology goes down and the quality of service increases, it is becoming cost effective for companies and individuals to extend the capability of wired networks by integrating wireless segments into their communications.
- Some of the most common devices used in wireless communication include access points, the antenna and the PCMCIA card.

I) ACCESS POINTS (AP)

- An entry point into a bounded network for people who have wireless devices such as PDAs, laptops and computers with wireless links.

II) WIRELESS ANTENNAE

- The access point needs to have antennas in order to detect signals in the surrounding.
- The waves may be radiowaves, microwaves or infrared waves in nature.
- In most cases, access points will have two antennas so that the one that receives the best signal at any particular time can be used.

III) PERSONAL COMPUTER MEMORY CARD INTERNATIONAL ASSOCIATION (PCMCIA) card.

- An add-on card inserted into a device such as PDAs or a laptop in order to enable wireless communication between the devices and a wired network server.

NETWORK SOFTWARE

- Can be classified into two main groups namely:
1. Network operating systems.
2. Network protocols.

1. NETWORKING OPERATING SYSTEMS

- Designed to optimize the networked computers ability to respond to service requests.
- Servers run on a network operating system.

Main network related functions of NT O.S.

i) Provides access to network resources e.g. printers.

ii) Enables nodes on the NT to communicate with each other more efficiently.

iii) Supports interprocess communication i.e. enables the various processes on the NT to communicate with one another.

iv) Respond to requests from application programs running on the network.

v) Supporting NT services like NT card drivers and protocols.

vi) Implementing NT security features.

- In most cases, NT O.S. is designed as multi-user operating systems that run the network server program.
- Once installed on the right hardware platform and configured as a server, the operating system will provide network management tools to network administrators for the to do the following:

i) Secure the network against unauthorized access.

ii) Track network usage and keep a log/record of all the people who use the network.

iii) Ensure inter-operatability between various systems on the network.

iv) Performance monitoring to ensure maximum throughput on the network.

Examples of NT operating systems:

a) Windows NT/2000/2003

b) UNIX

c) Linux

d) Novel Netware.

NB:

- Internetworking devices like routers also have operating systems of their own and hence they can be managed and configured for optimum performance.
- Routers are special purpose computers.

2. PROTOCOLS

- These are sets of rules and procedures that govern communication between two different devices or people.
- In computer networking, protocols refer to the rules and technical procedures that govern communication between different computers.

WORKING MECHANISM OF PROTOCOLS

- The data transmission process over the NT has to be broken down into discrete systematic steps.
- At each step, a certain action takes place.
- Each step has its own rules and procedures as defined by the NT protocols.
- The work of these protocols must be coordinated so that there are no conflicts or incomplete operations.
- This co-ordination is achieved through protocol layering.
- NT protocols are designed after the open systems interconnection (OSI) model.
- The OSI model is not a protocol as such but is meant to help designers to come up with high quality layered protocols.
- It has seven layers, each performing distinct functions as shown below:

	Layer	Function
7	Application layer	User applications run here and generate requests for data transmission or open received information.
6	Presentation layer	Adds formatting, display and encryption information to the data being sent.
5	Session layer	Sets up data transmission sessions between two communicating devices.
4	Transport layer	Manages data transfer over the network to ensure reliability.
3	Network layer	Address information is added to the packet and routing to destination.
2	Data link layer	Adds error checking information and prepares data for going onto the physical connection.
1	Physical layer	The data packets are finally transmitted via the network card through the transmission media in form of bits.

Application layer protocols:
- Application protocols work at the highest layer of the OSI model.
- They provide services to application programs.

Examples of application protocols:
a) An e-mail program that enables composing or reading of e-mail messages.
b) Simple mail transfer protocol (SMTP) – An Internet protocol for transferring e-mails.
c) File Transfer Protocol (FTP) – for file transfer.
d) Apple talk and apple share – Apple computers networking protocol suit.

Transport layer protocols:

- Ensure that data is passed between computers more reliably.

Examples of transport protocols

a) Transmission control protocol (TCP) - Responsible for delivery of sequenced data over the network.
b) Sequential Packet Exchange (SPX) - Part of the Novell's internet work packet exchange/sequential packet exchange (IPX/SPX) for sequenced data.
c) NetBEUI: a local area network protocol for Microsoft and IBM networks that establishes communication sessions between computers.
d) Apple transaction protocol: (ATP): Apple computer's communication session and data transport protocol.

Network layer protocols

- Provide link services.
- They handle addressing and routing information, error checking and retransmission of requests.

Examples of network layer protocols

a) Internet protocol (IP) – it does packet forwarding and routing.
b) Internetwork packets exchange: Netwares protocol for packet forwarding and routing.
c) NetBEUI: provides data transport services, Netbius sessions and applications.

4. DATA SIGNAL

- All messages that are sent and received through the network must be represented using a data signal.
- Metallic media would require an electrical signal, wireless media need electromagnetic signals while fibre optic cables need light signals.
- A signal can either be analog or digital.

NETWORK TOPOLOGIES

Topology:

- It is the physical arrangement of computers on a network.

- Refers to the way in which computers and other devices have been arranged or how data is passed from one computer to another in the network.
- It is the way in which the points or stations of a network interlink (interact together).
- It determines the data paths that may be followed or used between points in the network.
- Network topology can be viewed in two ways:

a) logical topology.

b) Physical topology.

A. LOGICAL TOPOLOGY

- Also called signal topology.
- Deals with the way data passes from one device to the next on the NT.

Examples of logical topology

i) Ethernet topology.

ii) token ring topology.

I) ETHERNET TOPOLOGY

- All computers listen to the network media and can only send data when none of the others is sending.

II) TOKEN RING TOPOLOGY

- A special package for data called a token goes around the network and only the computer whose address is on the data held in the token will take up the token to read the data and then release the token.
- The token can then be captured by another computer which needs to transmit data.

B. PHYSICAL TOPOLOGY

- Refers to the physical layout or arrangement of components on the network.

Examples of physical topology
i) Star topology.
ii) Bus topology.
iii) Ring topology.
iv) Mesh topology.
v) Tree/hierarchical topology.

I. STAR TOPOLOGY
- A set up where all devices are connected to a central hub/server/switch.
- A host computer is attached to locals through multiple communication lines.
- The local computers are not linked directly to each other.
- Between any two stations, communication is via the central computer.
- When the hub/central machine receives data from a transmitting computer, it broadcasts the message to all the other nodes on the NT.


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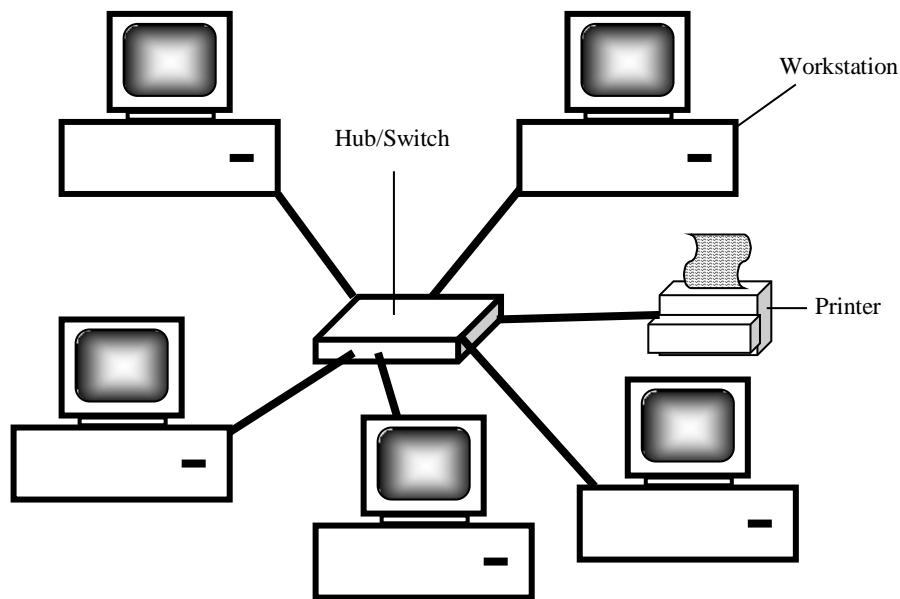
Star topology

ADVANTAGES OF STAR TOPOLOGY

1. Star networks are easy to configure.
2. network failures due to cables breakdown are low since cables are not shared.
3. failure of any computer does not affect communication in the NT, unless it has major effects on the host computer.
4. wiring hubs increases flexibility for growth i.e. additional and deletion of nodes does not involve interfering with the others.
5. allows centralization of key networking resources like concentrators and servers.
6. gives the NT administrator a focal point for NT management. It is easier for the administrator to troubleshoot and diagnose NT related problems.

Disadvantages of star topology

1. If the central hub fails, the entire network will be grounded.
2. Installation is time consuming; each node forms a segment of its own.
3. It is costly, requires one complete cable per computer.

II. BUS TOPOLOGY

- Also known as Daisy-chain topology or multipoint network.
- All devices are connected to a central cable called the bus or backbone.
- All stations are attached directly through appropriate interfacing hardware to the transmission medium.
- Each workstation on the network must be capable of knowing when it can and cannot transmit data using the shared medium, since the cable can carry only one message at a time.
- A terminator is attached to each end of the cable to avoid signals from bouncing back and forth on the cable causing signal distortion.
- As the data passes along the cable, each station checks whether the data is addressed to it.
- If the address matches the machine's address, it receives the data otherwise it rejects it.
- The network addresses of computers on a network is called the medium access control (MAC) address.
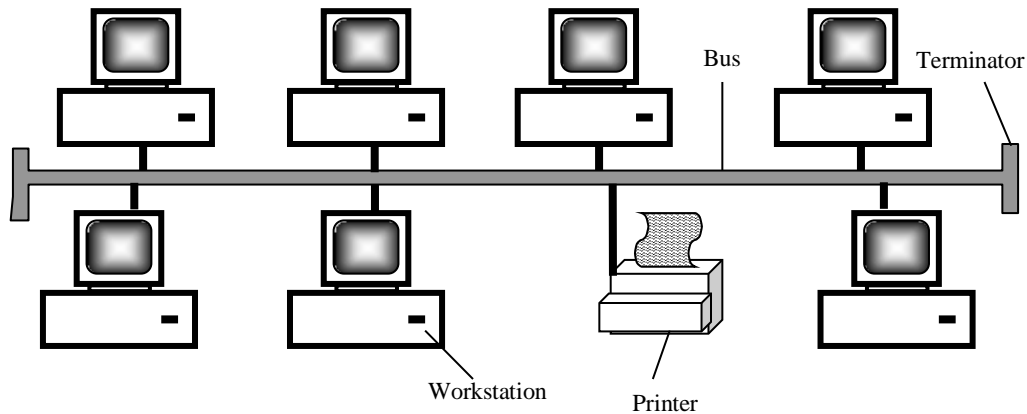
Bus topology

Advantages of bus topology
1. It is easy to install.
2. Requires less physical lines hence less costly.
3. It is independent i.e. any single computer can't affect communication between other computers.
4. Easy to expand, just need to add the new computer on the line.

Disadvantages of bus topology
1. Only one node can transmit signals at a time.
2. Failure or fault in the transmission line affects the whole communication network.
3. Troubleshooting a cable fault is difficult.
4. Limits the number of computers that can be connected to the cable. Increase in the number of computers results in an increased collision as machines compete for transmission.
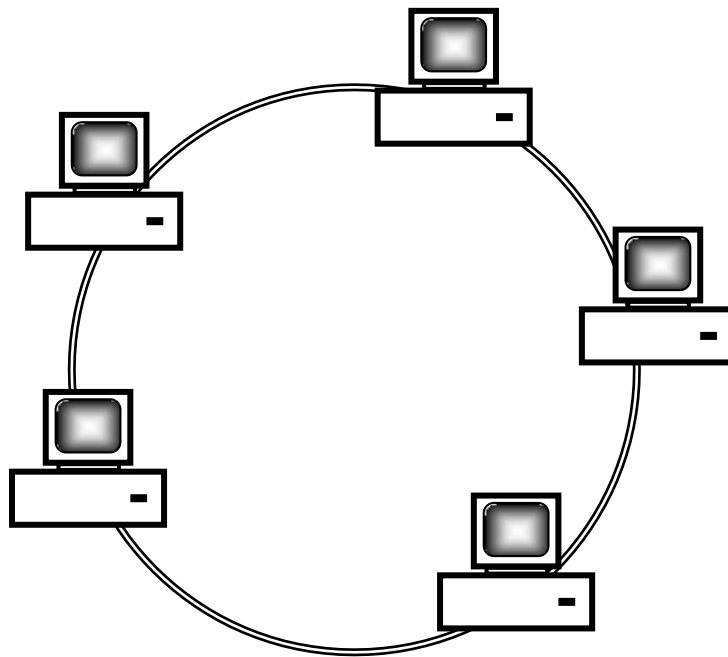
III. RING TOPOLOGY

- All devices are connected to one another in the shape of a closed loop.
- There is no host computer.
- Each station is responsible for regenerating and retransmitting signals around the network to its neigbour.
- It uses repeaters (devices that receive data at one end and transmit it bit by bit to the other end).
- A special bit pattern called a token is circulated around the ring sequentially from one node to the next and a node is only permitted to transmit data when it receives the token.
- A token can be viewed as an envelope or a bag where data is placed for transmission and carried around the network.
- All computers in ring topology have equal capabilities of sending and receiving.

Advantages of ring topology
1. They use short length cables – less costly.
2. Simple to install.
3. Very effective where there is distributed data processing.
4. More reliable because of alternate routing if one computer breaks down.
5. The packet delivery time is fixed and guaranteed.

Disadvantages of ring topology
1. Installation requires sophisticated software.
2. Delays in communication are directly proportional to the number of nodes the message has to pass through.
3. Requires a lot of reconfiguration when new nodes are added.
4. Troubleshooting can be difficult.
5. Token management must be robust because loss or corruption of the token can cause chaos.
6. One device or media breakdown may affect the entire network. However, this is not the case with IBM token ring where a device called Multi Station Access Unit (MSAU) is used for station bypass in the event a station fails.
7. Modification may be difficult because adding or removing a device can disrupt the entire network.

Ring topology

IV) MESH TOPOLOGY

- Most common type used in WAN, where there are many paths between different locations.
- Devices are connected with many redundant interconnections between the nodes.
- Every node has a connection to every other node in the NT, making possible for direct communication with every computer hence every computer dictates its priorities.

Advantages of mesh topology

1. The network is reliable and effective due to direct relationship between the computers.
2. Point to point connections optimize throughput of data.
3. The NT can still operate even when a node breaks down or a connection breaks.

Disadvantages of mesh topology
1. It is expensive on cable due to redundant links.
2. Administration of the network is difficult because of the peer to peer connections.

V) TREE/THERARCHICAL TOPOLOGY
- A hybrid topology.
- Groups of star – configured networks are connected to a linear bus backbone.
- It can also be derived out of breeding a combination of other networks.

Advantages of tree topology
1. Failure of one or more nodes does not affect the whole network.
2. Failure of a single branch does not bring the whole network down.

Disadvantages of tree topology
1. Communication path can sometimes become quite long.
2. Installation can become costly and complex.
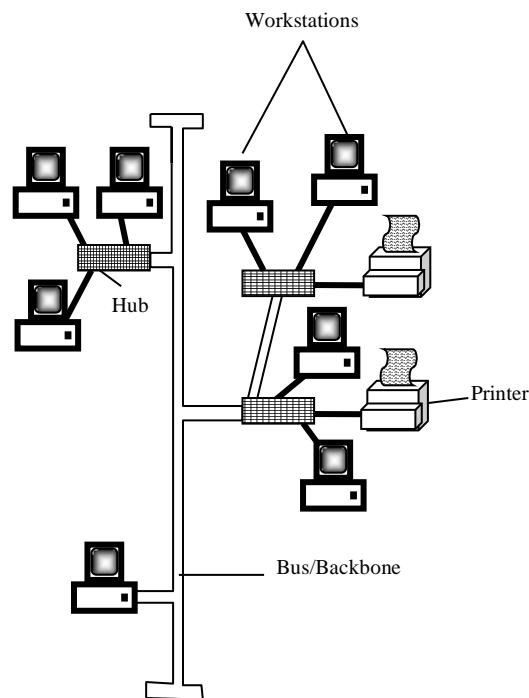
Tree topology

SETTING UP PEER – TO – PEER LAN
Hardware requirements

1. A computer running on any version of Ms Windows especially Windows 9x/2000/Me/Windows Xp.
2. Network interface card (NIC). Some computers may have it already installed onboard so that you do not have to purchase one.
3. A hub or a switch.
4. Transmission media preferably unshielded twisted pair category 5.
5. RJ45 connectors.

Tools

1. Crimping tool.
2. Cable tester.
3. Screw drivers.

NETWORK SECURITY

- In networking, there are several ways of enforcing security, one of them is share level and the other is user level security.

a) Share level security

- A simple network security used in peer to peer networks.
- The user can decide which resources to give for sharing.
- Most desktop O.S. such as Windows 9x provide such kind of security.

b) User-level utility

- Used on server based networks.
- A network administrator assigns accounts to users.
- Each user is provided with a unique name and password which he/she can use to access network resources.

APPLICATION AREAS OF ICT NOTES

INTRODUCTION

- There is rampant use of computers in the society today; offices, institutions, organizations and homes.
- Tasks that were previously manned manually are now tackled electronically.
- It is imperative to therefore understand ways by which computers have been applied in the contemporary society to add great value to the information systems of various organizations.
- **An information system** is a collection of specific human and machine efforts required to support the decision making process, data processing, information output and presentation.

APPLICATION AREAS

1	Financial systems.	9.	Entertainment systems
2	Retail systems.	10	Transportation system
3	Reservation systems	11	Home use
4	Educational systems	12	Office expert systems
5	Communication systems	13	Marketing
6	Industrial systems	14	Virtual reality systems
7	Scientific and research systems	15	Law enforcement systems
8	Library systems		

1. FINANCIAL SYSTEMS

- Enable organizations to manage their finances and they include:
a) Payroll systems.

b) Accounting systems.
c) Banking systems.

A. PAYROLL SYSTEMS

- Screens are setup to capture the transaction data, with appropriate validations, data is inserted into the transaction file, payroll programs then process the payroll using data from the transaction file, lookup tables and the master file.
- The master file is then updated, payroll system is produced, pay slips are printed for every employee and other reports required by management or the tax department.
- Computers are therefore used to store and process payrolls.
- Backing storage is also essential for payroll systems, since the amount of data grows with time.
- The primary purpose of the payroll system is to therefore process the accurate information of employees including gross pay, deductions and the net pay.
- The payroll system is designed to produce several analysis reports e.g. a breakdown of payroll expenses against production/income of the company.

B. ACCOUNTING SYSTEMS

- Accounting is the preparation and analysis of financial records for a commercial company, government or other organizations.
- Known as the " business language" , it enables decision makers to interpret financial information and use the results in planning for the future e.g. foretelling what products or departments are doing well and which ones are doing poorly.
- It deals mainly with numbers and this is a task well suited for computers.
- The processing of such tasks is simple and easy to understand to implement on the computer, and management can establish appropriate controls and error-checking procedures to ensure the security and accuracy of the data.

There are five major/key business accounting activities/subsystems as outlined below:
  i) Customer order and entry.
  ii) Inventory management.

iii)   General ledger accounting.

iv)Accounts receivable.

v) Accounts payable.

vi)Cash book.

I) CUSTOMER ORDERS ENTRY AND BILLING

- Used to record incoming customer orders, authorizes delivery of items or services ordered and produces invoices for customers who do not pay in advance or on cash basis.

II) INVENTORY MANAGEMENT

- Used to keep track of the items in stock and help the management determine which items to re-order, helping the management to have enough stocks at all times to meet the needs by customers.

III) GENERAL LEDGER ACCOUNTING

- Also known as nominal ledger.
- Contains a summary of all business accounts i.e. used to keep track of how much a business makes and its worthiness by summarizing the financial transactions in forms of balance sheets, profit and loss account, trial balance, day book/journal, list of accounts etc.
- It produces reports on income, sources of income, expenses and the net profit or loss earned.
- The summary report (balance sheet) is usually generated at the end of an accounting period.

IV) ACCOUNTS RECEIVABLE

- Keeps track of money owed to a company by its customers.
- This helps the management to make a follow up by billing the customers for overdue payments.
- An example is when goods are sold to a retailer; money owed on the sales is an accounts receivable item until the payment is received.

V) ACCOUNTS PAYABLE

- A system that keeps track of the amount the business owes others e.g. suppliers, tax organizations, transport etc.
- It therefore helps the management to produce cheques for payment of this amount.

VI) CASH BOOK
- Used to record daily cash transactions.
- It records the receipts and cash payments.
- The cash book has two accounts i.e. A cash account and the bank account.
- With the help of a cash book, the cash and bank balances can be checked easily.

2. BANKING SYSTEMS
- Since the introduction of the magnetic encoded cheques in the 1960' s, banks have become dependent on computers for many services.
- The banking industry was one of the earliest consumers of information and communication technology.
- The computerized banking services include:
  i) Processing customer transactions.
  ii) Cheque clearing and processing.
  iii)   Electronic funds transfer.
  iv)Internet banking.
  v) Mobile banking.

I) PROCESSING CUSTOMER TRANSACTIONS
- They are used in banks to carry out financial transactions such as recording deposits, withdrawals and calculating interests on savings and loans.
- Reports are also generated on the current status of accounts.
- The transactions are entered via terminals, which are connected to a central computer for centralized processing.
- ATMs are used to offer 24 hour service to customers and more flexibility in cash deposits and withdrawals.

II) CHEQUE CLEARING AND PROCESSING

- Computerized cheques clearing and processing is made possible due to the characters on cheques printed using ink containing magnetic particles.
- MICR enables the processing of the cheques hence time saving.

III) ELECTRONIC FUNDS TRANSFER (EFT)
- This is the movement of money between two different accounts using ICT, using a cash dispenser.
- The amount withdrawn by a customer is deducted from his/her account.
- Credit cards are also used when paying for goods and services where payment is transferred electronically from the customers account to the recipients account.

IV) INTERNET BANKING (e-banking)
- Enables users to access their bank accounts through the internet.
- The user can query account statements, pay bills and transfer funds electronically.

V) MOBILE BANKING (m-banking)
- An account holder in a bank can perform banking transactions using his/her mobile phone.
- The transactions may include cash transfers, settling bills electronically and performing account queries.
- Mobile phone companies like Safaricom support electronic cash transfer services with their M-Pesa service.

3. RETAIL SYSTEMS
- Used in supermarkets, distributor outlets and others for:
  i) Stock control.
  ii) Transactions handling at the EPOST.

I) STOCK CONTROL
- Stock control or inventory control enables a user to manage his/her stock more efficiently by keeping track of the stocks.
- Accurate and up-to-date information on availability of stocks and demand are critical for business success.

- It enables one to reduce the risk of under stocking or overstocking i.e. overstocking ties up valuable space and capital that could have been used for other valuable items while under stocking causes customer dissatisfaction.
- Stock control systems are therefore used for the following reasons:
  a) Storing full details of the items held in stock i.e. immediately available.
  b) Proving users with up-to-date information regarding stock items and prices.
  c) Monitoring stock levels so that items can be ordered in good time.
  d) Storing details of suppliers of stock items.
  e) Storing details of pending orders.

II) POINT-OF-SALE TERMINAL (P-OST, E-POST)

- Used to input and output data at the point where sales are transacted.
- It has direct data capturing devices like bar code readers, card readers, a monitor and a receipt printer, where goods are identified by means of bar codes.
- Transactions at the P-OST may involve the following steps:
  a) The BCR (wand) is passed over the item's bar code.
  b) The barcode is automatically converted to the item number e.2. 2160, which is read to the computer.
  c) Using the number, the computer searches for the item from a master file with a corresponding number in the products database.
  d) Once the record is found, its description and price lookup file is used for processing the sale.

Advantages:
  a) Correct prices are used at the checkout counter.
  b) It is faster since the attendant does not have to enter details manually.

4. RESERVATION SYSTEMS:

- These are distributed networked systems that are used mainly to make bookings in areas such as airlines, hotels, car-rental, theaters etc.
- Bookings are made from a remote terminal connected to a centralized computer database.
- To access the database, a customer makes enquiries via the remote terminal connected to the central computer.

- It involves online enquiry where an individual directly requests for information through a terminal from a central computer and receives an immediate response.

5. EDUCATIONAL SYSTEMS

- Computers are playing an increasingly important role in educational institutions in the following ways:
  - i)   Computer Aided Instruction (C.A.I.)
  - ii)   Computer Aided Learning.
  - iii)   Electronic Learning (e-learning).
  - iv)   Computer based Simulation.

I) COMPUTER AIDED INSTRUCTION (C.A.I.)

- Refers to the use of a computer to learn, drill and practice particular educational principles.
- It entails learning new languages, educational games, typing tutor's programs etc.
- In a geography map, the student must provide the names of cities, mountain ranges, names of rivers, lakes etc.
- A biology student may be asked to name or position internal organs, muscles or bones in a picture of the human body.

II) COMPUTER AIDED LEARNING (C.A.L.)

- It presents educational materials the way a teacher does in a classroom.
- Most CAL programs have clear graphical presentations such as video clips and voice for demonstrating or explaining difficult concepts.

III) ELECTRONIC LEARNING (e-learning)

- This is where lectures are presented from a central site and the presentation is transmitted to remote conference terminals or displayed on TV screens.

- The learner can also access learning materials on the Internet, sit for online exams and receive results the same way, also known as Computer Based Training (CBT) and Web Based Training (WBT) systems.
- Some of the key benefits are:
  a) Learning time is reduced, thorough and consistent.
  b) Instant availability of courses at any time.
  c) Eliminates the need for classroom instructors.
  d) Minimizes travel time, costs and time away from the workplace.
  e) Learners do not need to go physically to a college.

IV) COMPUTER BASED SIMULATION

- Refers to the science of representing the behaviour of a real – life situation by using computerized models.
- Simulation programs are mostly used in educational areas where practical skills have to be learnt like training drivers, pilots, engineers etc have to be instructed using a virtual environment.
- Satellite technology and the Internet are used to provide quality educational content from all over the world at an affordable cost.
- Courses and seminars are beamed by satellite on large screen projectors, TV monitors or computers.
- Students interact with the instructors in real-time using phone, fax and e-mail.

6. COMMUNICATION SYSTEMS

- Communication refers to the distribution of information or data from one person or location to another.
- Effective and efficient data communication is achieved by use of high-speed electronic devices such as computers, cell-phones, radios and television.
- The integration of computerized computer devices and telecommunication infrastructure for the purpose of communication is referred to as information and communication technology.

Examples of communication systems are:
  i)   Facsimile (Fax)

ii) Radio.
iii) Television set.
iv) Video conferencing.
v) Telecommuting.
vi) Internet.

I) FACSIMILE (FAX)

- A computerized system that is capable of transmitting complete images from one location to another via telephone lines.
- Digital images can be transmitted in aerospace programs into digital code that can be understood by computers.
- The images include pictures, graphs, drawings, photographs, signatures or text.
- Copies of documents are transmitted electronically and the duplicate received at the recipient's machine i.e. can be referred to as distant photocopying.
- To send fax over the internet, a special modem called a fax modem is attached to the sending and receiving computers.

Advantages of facsimile communications:

a) The ability to transmit an image over long distances is less than 10 seconds.
b) The ability to confirm the receipt of a transmission quickly.
c) Low cost for high-volume operations.
d) There is guaranteed security – the transmitted image is sent as a digitized code (which can be scrambled) rather than a usable picture.
e) Convenience – the ability to store the resultant image on a computer file instead of apiece of paper.

II) RADIO COMMUNICATION

- Computers can be used in radio broadcasting stations to do the following:
a) Record and manage radio programmes meant for broadcasting.
b) Manage the radio transmission and track performance.
c) Automate the running of the selected programmes.
d) Create slides, simulated objects and sound effects when preparing electronic and printed media advertisements.
e) Download information from Internet that can be used in preparing programmes such as international news.

III) TELEVISION SETS

- Data or information is transmitted via a TV channel and the most common types of data transmitted via TV include:
  a) Teletext (ceefax)
  b) Videotext (view data)
  c)

a) Teletext

- Refers to a computerized service whereby news and other information are provided on the television screens to subscribers.
- The TV is configured using a special add-on card or adapter.
- The subscriber can browse for information using a remote controlled device.
- It is however one way communication (simplex).

b) Videotext (viewdata)

- A two way communication service (half-duplex) over a telephone line or cable TV channel.
- A subscriber can interact with the service provider database and the information is displayed on a home TV screen.
- Videotex is used in reservation bookings, ordering for goods and services as well as sending e-mails.
- Users of videotex can interact with the database to pay bills, order goods etc.
- The services supplied through videotext and Teletext systems include:
  - ✓ Information on weather, TV programmes, sporting events, current news, holiday opportunities, airline schedules and stock market data.
  - ✓ E-mail – transmission of electronic messages to other users.
  - ✓ Paying bills, ordering goods and purchasing tickets.

IV) VIDEO CONFERENCING

- Refers to the use of computers, a digital camera, an audio capturing equipment and communication networks to enable people in different locations to see and talk to one another.

- Each participant's computer is attached with a video camera (camcorder), speakers and a microphone.
- A person can therefore participate in a virtual conference room.
- All participants see each other on the computer screen as if they were sitting in a real conference room.
- Video conferencing is popular in TV broadcasting stations where a field reporter interacts with newscasters and in organizations where top managers in different geographical locations hold meetings via the Internet or the organizations intranet.

V) TELECOMMUTING

- A situation where an employee works usually at home using a computer connected to the workplace network.
- It is an arrangement in which employees use microcomputers and modems to communicate with their business offices while they work elsewhere.
- Telecommuting takes advantage of the growing communication networks to reduce unnecessary travel to the place of work, reducing travel expenses and less stress due to commuting inconveniences such as traffic jams.
- Telecommuting may be practical for:
  a) Writers.
  b) Engineers.
  c) Architects.
  d) Mothers with small children.
  e) Handicapped workers.
  f) Individuals whose fields work take them far from the office.

- This arrangement can also be practical since employees who telecommute:
  a) May use less office supplies like photocopying.
  b) Do not occupy valuable office space.
  c) Do not waste time commuting in cars, trains or buses.
  d) Do not waste time conversing idly or suffering the petty distractions of office life.

VI) THE INTERNET

- A world – wide computer network linking countless thousands of computer networks for information transfer and efficient communication.
- Some of the services available on the internet are:
  a) world wide web (www)
  b) electronic mail (e-mail)

a) World wide web (www)

- A collection of web pages held on web servers.
- One can access information using a computer or any other communication device such as a mobile phone for WAP (wireless Application Protocol).
- A computer connected to the Internet allows the user to access a wide range of information such as news, entertainment, banking, reservation, business news, e-mails etc.

b) Electronic mail (e-mail)

- Fast and efficient means of sending and receiving messages, data, files or graphics.
- Once you subscribe for Internet Services through a service provider, you can send or receive e-mails to or from anyone connected to the Internet using a computer or a WAP – enabled cellular phone.
- Documents can be created, distributed, filed, stored and destroyed electronically using a computer.
- A user with a micro-computer and a modem types a message and then identifies the message recipients, using e-mail addresses.

Advantages of e-mail:

✓ You do not create written documents.
✓ You avoid at least some telephoning, eliminating busy signals, dealing with intermediate secretaries, leaving messages or playing " telephone tag" i.e. repeatedly missing each others' calls.
✓ Messages are delivered much faster than postal delivery since they are sent electronically and therefore received nearly instantaneously.
✓ In many circumstances, e-mail is both cheaper and more convenient than phoning.

✓ You can time-shift messages, i.e. you can send messages to people in different time zones even though they might not be awake.
✓ You can mass-distribute messages using computerized lists of recipients e.g. sales representatives.

7. INDUSTRIAL SYSTEMS

- Industrial plants such as motor vehicle manufactures, chemical plants, refineries and mining plants use computer systems in the following ways:
    i)   Computer Aided Design and Manufacturing
    ii)   Simulation.
    iii) Process control.

I) CAD and CAM

1. CAD/CAM is an integrated system that allows products that have been designed to be transmitted into an automated manufacturing system for the product to be manufactured as per the computer model.
2. The computer model is designed using special software, usually capable of displaying 3D representations of solid objects, which allows the designer to view the object from different angles and modify the design until it is satisfactory.
3. The CAD software will often generate a 3D view from a plan, side elevation and front elevation of the object.
4. The final design can therefore be used directly to create manufacturing information and to provide information on quantities of materials required to produce the item.

CAD hardware:
   a) a graphics workstation that allows the designer to interactively create a drawing.
   b) A high resolution screen (display) to show drawings in colour and in fine detail.
   c) Fast processors with a great deal of memory.

USES OF CAD AND CAM SYSTEMS:

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a) Engineering designs for roads, chemical plants, machine parts, aircrafts, cars etc.
b) Pattern design for clothing, architectural design and kitchen design.
c) Robotics for carrying out assembly line operations, welding, lifting heavy objects, spray painting of vehicle bodies etc.

II) INDUSTRIAL SIMULATION

- Computer simulation is the designing of models of an actual or theoretical physical system, and analyzing the execution output using digital computers.
- This allows some activities that would otherwise be expensive and dangerous in real life situation to be put under test.
- It enables manufacturers identify some of the weaknesses of the real situation or object, hence put the correct reinforcement to their designs.
- An example is how motor vehicles seat belts are tested for their effectiveness in case of a car crash.
- The general name of using computer models in such circumstances is known as non-destructive testing (NDT).
- Computer simulation is widely used in various areas of human endeavour and some of the applications include:
  a) in aviation where computers are used for training pilots, where a pilot feels as if he were controlling an actual aircraft.
  b) In engineering, models are simulated to test performance under various conditions e.g. the strength of material to be used for building a bridge can be tested using simulators.
  c) In medicine, simulation can be used to train doctors on operation techniques.

III) PROCESS CONTROL

- Refers to the use of a computer system to control an ongoing physical process especially in manufacturing.
- Such controls may include regulating temperature, pressure, fluid flow etc.
- Computerized process control is mostly used in petroleum refineries, chemical plants and other manufacturing companies to manage machine intensive processes.

8. SCIENTIFIC AND RESEARCH SYSTEMS

- Computers have a wide variety of applications in science, research and technology, some of which are:
  - i)   Weather forecasting
  - ii) Medical research
  - iii) Military and space exploration science.

I) WEATHER FORECASTING

- Computers help analyze current weather, they help predict the impending weather, and they help create the visual images used for broad cast TV.
- Due to the large volume of data collected from rainfall, air pressure, humidity, temperature, wind speed and cloud cover, computers help in analyzing, processing and predicting weather patterns using such data.
- Another application of computers in weather forecasting is the use of geographical information system (GIS) and the geographical positioning system (GPS) which represent geographical data in graphical form by positioning and superimposing it on the world map./
- GIS is used to represent data on weather patterns in a clearer and a coherent/logical manner on a world map.

II) MEDICAL RESEARCH

- Medical automation offers great assistance in the areas of automatic diagnosis, electrocardiogram screening and monitoring.
- Health professionals use computers technology for diagnosis, keeping patients' data/records, inventory control etc.

- Computers are also being used to control devices that help to care for the handicapped such as the deaf, blind, bedridden etc.
- A doctor needing specialized opinions can now easily retrieve such information from computer storage.
- Computers also allow access to expensive foreign expertise for hospitals in one country to use consultants or even surgeons in another.

III) POLICE MILITARY AND SPACE EXPLORATION SCIENCE

- Computers are used in fighting crime.
- Police are now able to keep databases of finger prints which are automatically analyzed by computers.
- Computer based face recognition and scene monitoring and analysis help the police force in leading to arrest of offenders and criminals.
- In defense, computers are used in electronic, efficient communication, detection and tracking of targets, radar systems, warning systems and military laser and guided missile systems.
- Computer technology is the backbone of space explorations.
- From studying the movement of stars, surface of mars, we rely heavily on computers.
- Space explorations and military research bodies such as America's national aeronautics and space administration (NASA) make extensive use of computer systems for research, design, development and control of unmanned spaceships, aero planes and missiles.

9. LIBRARY SYSTEMS

- Libraries use computerized systems for a number of tasks e.g.
  i) Lending system.
  ii) Inventory control system.
  iii) Cataloguing system.

I) LENDING SYSTEM:

- Used to manage the issuance and return of borrowed reading materials.
- Books, magazines, journals, reports etc are given unique identification numbers or codes.

- Once a member borrows a book, his/her details are recorded and when the book is returned, the borrower's record is updated to reflect the new status.

II) INVENTORY CONTROL:

- Involves use of computers to manage stock, which includes checking for books currently in the shelves and those on high demand for the purpose of adding more.
- Books that have become obsolete can be retired to the archives.

III) CATALOGUING

- A catalogue is a collection of cards with information about each book or reference materials found in the library.
- To enhance service delivery and efficiency, computerized cataloguing has replaced the manual cards catalogue.
- An electronic catalogue is updated constantly when new reference materials are acquired.

10. ENTERTAINMENT SYSTEMS

- The advancement in multimedia technology has produced computers that can be used in recreational and entertainment.
- Some application areas of computers in recreation and entertainment include:
  - i)   Games.
  - ii)   Music and video.

I) GAMES

- Digital video disks (DVDs) and 3D multimedia games are now used to add stereo sound and digital video clips to make games more and more realistic.
- There are computer games that simulate sports such as driving, war combat etc.
- Such games give the player maximum pleasure in a virtual environment on the screen.

II) MUSIC AND VIDEO
- Video compact discs (VCD) and digital video disks (DVDs) have become a common feature in the entertainment industry.
- In music industry, computers are used in recording, synthesizing, editing and adding special effects to music.
- In video, computers are used to produce highly simulated and animated movies, generate scenes and actors.
- Many special effects are being created by using computer graphics techniques to produce animated, 3D images.

11. TRANSPORTATION SYSTEMS
- Computers play an increasingly important role in transportation industry in the following areas:
  - i)   Automobile traffic control.
  - ii)   Air traffic control.
  - iii) Shipping control.

I) AUTOMOBILE TRAFFIC CONTROL
- Optimum utilization or road capacity is achieved by good coordination of traffic signals.
- Traffic control lights are controlled using a computer system.
- Computerized traffic light systems have sensor pads laid underneath the road which detect the pattern of the traffic flow.
- Computers can then be used to automatically generate and implement traffic signal plans.
- Data is collected, sent to a computer system which detects and analyses the traffic flow and builds up a simulated image of the actual scene.
- Control signals can then be output to the traffic lights or motorists through their receiver devices to vary the light timings or redirect traffic to less busy roads.

II) AIR TRAFFIC CONTROL
- Geographical positioning system (GPS) is a computer technology that is used to direct aircrafts to follow the shortest path between two locations.

- Air traffic controllers are used to coordinate the movement of thousands of aircraft, keeping them at safe distances from each other, directing them during take-off and landing from airports, directing them around bad weather and ensuring that traffic flows smoothly with minimal delays.
- Details of every flight plan (airline name, flight number, type of aircraft and equipment, intended airspeed, cruising attitude and flight routes) are stored in a computer.
- The computer generates an flight progress strip that is passed from controller throughout the flight.
- All systems within the control tower also make extensive use of microprocessors to track aircrafts and convey information between different control towers in different air spaces.

III) SHIPPING CONTROL

- Computers are widely used to control and guide the paths taken by spaceships and water vessels as they travel to distant lands.
- The use if It has permeated into the shipping industry for efficient management of the fleets, cargo handling, communication and much more.
- Ships also make extensive use of computer and communications technologies and modern ships have sophisticated microprocessor based control systems for steering the ship.

12. HOME USE

- Most people are now using computers at home for preparing domestic budgets, entertainment, research and teaching children on education concepts, typing and printing, e-mail, internet etc.
- Also used for storing personal information and databases of inventory records.

13. OFFICE EXPERT SYSTEMS

- An information system usually developed and installed in the office of a human expert or knowledge worker.
- Such a system is capable of simulating the decision making process and intelligent problem solution just like a human expert.

- It also has a set of rules that help it to make conclusion when some parameters are entered.

14. MARKETING

- Computers are being used in a number of ways to enhance marketing, through:
  - i)   E-commerce or e-business.
  - ii)   Electronic presentations.
  - iii)   Advertising.
- Marketing is the planning, pricing, promotion and distribution of goods and services from producers to consumers

I) E-COMMERCE / E-BUSINESS

- Transactions are carried out electronically without physical interaction between the seller and the buyer.
- A customer can visit a supplier's website; select an item and placing it in a virtual shopping tray.
- The website then tracks the whole session as the customer chooses various items and calculates the total bill.
- Payment is then made through a cheque, credit card or through electronic funds transfer and the item is subsequently shipped to the customer.

II) ELECTRONIC PRESENTATION

- Marketing agents can use computers to create exciting presentations concerning the products of a business and present them to the audience using presentation software.
- Electronic presentations by use of slide transitions add value to traditional marketing techniques because they are attractive.

III) ADVERTISING

- Using simulation, presentation and animation software, it is possible to design catchy advert materials and video clips.
- Such materials can then be displayed on billboards, broadcasted over a television or placed on the internet.

- Computers cam also be used in market analysis which focuses on such matters as the product life cycle, sales strategies, market share of competitors and sales call strategies.
- Sales analysis is used to provide information on which products are selling well and which are selling poorly, which sales people have the best and worst sales and which sales people are selling the most and the least etc.

15. VIRTUAL OR ARTIFICIAL REALITY

- VR or AR refers to a condition in which a person becomes psychologically immersed in an artificial environment generated by a computer system.
- It is a way for humans to visualize, manipulate and interact with computers and extremely complex data.
- Other terms used instead of VR are cyberspace, virtual worlds and virtual environment.
- To achieve this effect, the following interactive sensory equipment are used:
    - i) Head mounted display / head gear.
    - ii) Gloves.
    - iii) Body suit.
    - iv) Virtual reality software.

I) HMD/head gear

- It is made up of two tiny display screens and sound systems that channel images and sound from the source to the eyes and ears thus presenting a stereo 3D sound effect in the virtual world.
- It uses some sort of helmet visor or goggles to place small video displays in front of each eye, with special optics to focus and stretch the perceived field of view.
- A boom is an alternative to the often – uncomfortable head gear.
- Screen, optical and sound systems are housed in a box and the user looks into the box through the two screens to see the virtual world.

II) GLOVES

- These are worn on hands to allow the user to navigate through the virtual world and interact with virtual objects.

- The gloves have sensors that collect data about the movement of the hands and relays the data into the system.
- They give the wearer a sense of touch in the virtual world.

III) BODY SUIT

- A body suit, worn during virtual reality session is made up of conductor wires wound in a rubber suit.
- The wires sense the body movement and relays the data into the virtual reality system which in turn adjusts the position of the user in the virtual reality world.
- Full body suits with position and bend sensors have been used for capturing motion for character animations, control of music synthesizers etc.

IV) VIRTUAL REALITY SOFTWARE

- VR software such as body electric gives the wearer of the sensory devices an interactive virtual sensory experience that makes him/her feel as if he/she is in a real world.
- The software is responsible for simulation of all aspects of the virtual reality world.

APPLICATION OF VIRTUAL REALITY

- Used to present any 3D object or ideas that are either real or abstract.
- Real objects include buildings, landscape, underwater shipwrecks, space crafts, human anatomy, sculptures, crime scene reconstruction, solar system etc.
- A house can be simulated before the actual building is physically setup – s client can be allowed to virtually move through the house, pull drawers and touch objects all in a computer generated environment.
- In entertainment, training in areas such as medicine, military, equipment operations, education, design evaluation, prototyping, simulation and assembly of sequences, assistance to the physically challenged etc.

16. LAW ENFORCEMENT SYSTEMS

- Biometric analysis using computers is becoming a preferred tool i.e. deals with the study, measurement and analysis of human biological characteristics.
- Biometric devices attached to a computer are used to identify people by recognizing one or more specific attributes such as fingerprints, voice, lips, facial features like iris colour etc.
- Some of the devices include video cameras and biometric scanners.

<u>PERSONAL NOTES</u>

IMPACT OF INFORMATION TECHNOLOGY ON SOCIETY

ISSUES RESULTING FROM THE USE OF ICT

An impact is a positive or a negative effect. ICT sector, like any other sector has its positive and negative effects at different levels in society.

1. Effects on employment.
2. Effects on automated production.
3. Issues of workers' health.
4. Environmental issues
5. Cultural effects.
6. Breakthrough in ICT.

1. EFFECTS ON EMPLOYMENT:

The introduction of computers in the workplace has resulted in the following:

a) Creation of new jobs.
b) Replacement of computer illiterate workers.
c) Displacement of jobs that were formerly manual.

A. JOB CREATION:

- It has introduced new employment opportunities that never existed before.
- The use of computers in financial institutions, reservation systems, educational institutions, communications etc. has created new job titles such as computer operators, programmers, network administrators, It or IS managers, database administrators, software developers, system analysts etc.

B. JOB REPLACEMENT:

- This is a situation whereby certain jobs disappear in an organization but reappear in another form requiring high skilled manpower.
- Some clerical and repetitive tasks that required a large number of employees have been made redundant.
- Computer illiterate people have been replaced with those who have the desired computer skills.

C. JOB DISPLACEMENT:

- An employee is moved to another place or department where computer skills are not required, especially those not willing to acquire new skills of using the computerized system.
- To avoid losing competent employees, most employers organize in-service training for their employees on regular basis in order to help them keep up with the rapid changes in ICT.

2. EFFECTS ON AUTOMATED PRODUCTION:

- Refers to substituting mechanical and electronic devices for manual ones for more productivity i.e. the use of mechanical, electrical and electronic devices to improve the quality and speed of office work.
- A number of manufacturing industries such as vehicle assembly plants, oil refineries and food processing companies are using computers to automate their processes with an aim of increasing production.
- Computer controlled robots and assembly lines are a common feature in manufacturing industries.

ADVANTAGES OF USING AUTOMATED PRODUCTION:

a) Increased efficiency due to the balancing of workload and production capacity.
b) Improved customer service because of adequate and high quality goods
c) Faster which are produced in time.
d) Efficient utilization of resources such as raw materials, personnel and equipment hence
e) Less operating expenses incurred.
f) Helped in reduction of accidents in sectors like mining and chemical production where much work is potentially hazardous.

DISADVANTAGES:

a) High initial cost of setting up an automated system.
b) May lead to unemployment in some areas that are labour intensive.
c) Possible lack of compatibility with software and hardware.
d) Overreliance on automated systems leads to laziness.
e) Resistance to change.

REASONS WHY EMPLOYEES MAY RESIST AUTOMATED SYSTEMS

a) Fear of change: people are creatures of habits and hence are afraid of change.

b) Fear of loosing their jobs: people usually associate the computer with loss of jobs and hence they will be afraid that they might end up loosing their jobs.

c) Fear of failure: since the computer is very new in a given working environment, the people will be afraid that they might never adapt to it.

d) Loss of control: the management will be afraid that once a computer is implemented they might lose control of the organization.

e) Lack of understanding: the user may not understand the benefits of the computer system in their jobs; hence this will create resistance since the computer will be looked upon as an intruder.

3. ISUES OF WORKERS HEALTH

- Some of the negative effects of ICT on our health include:

a) Repetitive Strain Injuries (RSI)

b) Eye Strain and Headaches.

c) Electromagnetic emissions.

d) Stress.

e) Isolation.

f) Radiation and visual display unit.

g) Computer chip toxin.

A. RSI – REPETITIVE STRAIN INJURIES

- Injuries resulting from wrist, hand, arm and muscle strain, neck strains due to forced repetitive movement e.g. when entering data using keyboard.

Remedy for RSI:

i) Resting.

ii) Sitting in a relaxed position.

iii) Changing typing techniques.

B. EYE STRAIN AND HEADACHES:

- Since computer users have their eyes at close range with the monitor, there is danger of developing computer vision syndrome (CVS).
- The syndrome is characterized by:

i)   Eye strain.
ii)   Headaches.
iii)   Double vision.
iv)   Fatigue.

Remedies:
i)   Use monitors with good resolution.
ii)   Fit monitors with antiglare screens that filters excess light.
iii)   Adjust the brightness of the screen to the intensity that is comfortable to the eyes.
iv)   Use flat panel screens that do not emit so many radiations.
v)   Use good overhead fluorescence tubes.
vi)   Avoid flickering monitors and lighting systems.
vii)   Have interludes of rests.
viii)   Tilt the monitors to a convenient position.

C. ELECTROMAGNETIC EMMISIONS:

- These are waves of electrical and magnetic energy that are emitted by current carrying conductors.
- Users are advised to use low emission devices in order to avoid exposing themselves to excess emissions.

D. STRESS:

- Mental stress is another compliant.
- Many people who work at computer feel that they are expected to produce more and do it faster because computers themselves are fast.

- Also those being monitored by computers frequently feel additional pressure.

E. ISOLATION:

- People can conduct business and communication without ever coming face to face.
- Computer operators can work an entire shift, taking their instructions from a computer screen, sending and receiving memos to each other electronically without engaging in personal conversation.
- These people feel isolated from other workers.

F. RADIATION AND VISUAL DISPLAY UNIT:

- There have been reports that VDU emits radiations that cause birth defects, blindness, cancer, miscarriages, sterility etc.

G. COMPUTER CHIP TOXIN:

- Workers in computer chip manufacturing industries are exposed to toxic chemicals that may pose health factors similar to those feared from VDU.

ERGONOMICS:

- The science of designing the work place for the comfort and safety of the worker.
- It is the study of how living and working conditions can be adapted to the information technology.
- The need for better working environment has resulted to designing of special furniture to prevent backaches, and special monitors to prevent eye strain etc.

4. ENVIRONMENTAL ISSUES:

i)   Energy consumption and radiation:

Initially, computers consumed a lot of energy thereby generating a lot of heat and emitting electromagnetic radiations which are harmful to the user.

Remedy:

- Electronic devices have to be energy star compliant launched by the Environmental Protection Agency (EPA) to encourage minimal use of power by electronic devices.

ii)   Environmental issues:

- Huge garbage dumps of dead computer parts, printers, ink toner cartridges, monitors and other computer accessories are disposed in landfills hence causing environmental pollution.
- There has been concern on the disposal of Nickel-cadmium laptop batteries that contain toxic cadmium which when buried in a landfill can leak into underground water tables and catchment areas.

5. CULTURAL EFFECTS
i) Moral effects:

- The rapid growth of ICT also presents challenges to our moral and cultural values.
- ICT has changed the way we talk, affected our privacy, human rights and integrity.
- Humans are exposed to flaming i.e. writing on-line messages that use derogatory, obscene or dirty language.
- One can access and view pornographic materials that can lead to moral decadence.
- The free flow of immoral information has negatively influenced the behavior of both young and old in the society.
- To some extend, people with eroded integrity have used computers as a tool to accomplish their vices e.g. forging certificates, passports and other documents. This means that the person is cheating and therefore his/her moral integrity has been compromised.
- On the contrary, ICT has been used as a campaign platform against diseases like AIDS and drug abuse.

ii) Computer crimes:

- This is the use of computer software for illegal purpose.
- Computer related crimes such as hacking, eavesdropping, piracy are on the increase.

TYPES OF COMPUTER CRIMES

a) **Data manipulation:** Refers to altering data that enter or exit a computer e.g. changing data on a certificate.

b) **Time bomb:** This is the coding of a computer program to destroy itself after it has been run a certain number of times.

c) **Computer virus:** A program entered into a computer with the aim of destroying or altering data and spreading the destruction to other computers on a network.

d) **Trap door:** Creating of a special password that gives its creator a sole access to the system.

e) **Data stealing:** Using a computer to steal information that has been gathered for someone else for illegitimate purpose.

f) **Eavesdropping:** Tapping without authorization into communication lines over which computer data and messages are sent.

g) **Industrial espionage:** Using computer to steal designs, marketing plans or other trade secrets from one company and selling them to another company.

h) **Piracy:** This is making unauthorized copies of copyrighted computer software.

i) **Fraud:** This is the use of computers to cheat other people with the intention of gaining money or information.

j) **Sabotage:** This is the illegal destruction of data and information with the aim of causing great loss to an organization.

k) **Logic bomb:** It is a program that is executed when a certain set of condition is made e.g. a fired employee can load a logic bomb to a computer to destroy when records are updated in a database.

BREAKTHROUGHS IN ICT:

There have been a lot of breakthroughs in the fields of:

- Health care.
- Education.
- Communication – fax, e-mail, internet.
- Research.
- Commerce – shipping imports and exports.
- Art and design.
- Entertainment – music, video, games.

- Transport.

EVOLUTION OF COMPUTER SYSTEMS:
Future trends in ICT will be characterized by:
1. Rapid evolution in computer hardware and software.
2. Artificial intelligence.
3. Expanded information superhighway.

1. RAPID EVOLUTION IN COMPUTER HARDWARE AND SOFTWARE
- A lot of technological improvements have been made both in hardware and software since the introduction of computers.
- Computers will be more intelligent, computers will be able to learn in their environment, understand human voice, respond etc.
- Software will be more **versatile** and easier to use.
- The silicon revolution has seen rapid increase in microprocessor speeds and capabilities due to advanced research in the semi-conductor industry.
- Future trends will see reduction in size and cost of components but increase in capability.
- Improvements in input, processing, storage, output and communication devices have led to faster, cheaper and more reliable data processing devices.
- Industries will become more automated.
- Microprocessors of a thumb's size can now execute instructions in a trillionth of a second hence leading to emergence of smaller but smart devices.

2. ARTIFICIAL INTELLIGENCE (A.I.):
- A branch of computer science that is concerned with the development of machines that emulate/copy/mimic human like qualities such as learning, reasoning, communicating, seeing and hearing.

- The idea of AI developed from a need to develop computer programs that would even challenge human beings in playing games such as chess and scrabble.
- Computer scientists and engineers are still working hard and carrying out intensive research with the aim of coming up with smatter computers which can almost simulate human thinking and learning, instead of relying on static programmed instructions.
- There are 4 main application areas of AI namely:

  a) Expert systems.
  b) Natural language processing.
  c) Voice recognition.
  d) Voice synthesis.
  e) Computer vision
  f) Artificial neural networks.
  g) Robotics/perception systems

A. EXPERT SYSTEMS:

- This is software that is designed to make a computer operate at the level of a human expert in a specific narrow area of specialization.
- Such software simulates/imitates the reasoning process of experts in certain well defined areas such as medical diagnosis, financial forecasting, maintaining locomotives, locating mineral deposits etc.

COMPONENTS OF AN EXPERT SYSTEM:
i) Knowledge base:
This is the database/store of knowledge about a particular subject. It contains relevant facts, believes, assumptions and procedures for solving a particular problem.

ii) Inference engine:

This is Software that controls the search for knowledge in the knowledge base and produces conclusions. It takes the problem posed/given by the user and seeks to analyze it in order to arrive at a conclusion.

iii)   User interface;

This is the display screen that enables the user to interact with the system.

EXAMPLES OF EXPERT SYSTEMS:

i) MYCIN: used for diagnosis of blood and treatment of bacterial infections.
ii) DELTA: for maintaining locomotives.
iii) MUDMAN: predicting mineral deposits in geological exploration by analyzing composition of soil samples.
iv) STEAMER: training boiler room technicians in the navy.
v) R-1: designing computer systems for customers.

ADVANTAGES OF EXPERT SYSTEMS:

1. They can perform some tasks much faster than a human being.
2. They can easily identify faults in equipment.
3. The computer can store much more information than a human.
4. The system gives impartial and consistent recommendations.
5. The computer does not ' forget' or make mistakes.
6. Data can be kept up to date.
7. Always available 24 hours a day and will never retire.
8. The system can be used at a distance over a network.

DISADVANTAGES OF EXPERT SYSTEMS:

1. They can make mistakes and fail to learn from them.
2. They work best when the problem is specific and well defined hence complex and costly to design.
3. They lack human touch i.e. they can' t be questioned further.
4. Heavy use of them can make human experts lose their jobs.

B. NATURAL LANGUAGE PROCESSING:

- Aimed at coming up with programming languages that would make computers recognize and understand natural languages, whether spoken or written.
- Currently, there are voice recognition input devices and voice synthesizers are available but limited to just a few vocabularies.
- Before using them, the computer program must be trained to recognize the voice and the pronunciation of words by the user.

C. VOICE RECOGNITION:

- This is a system that will allow voice input.
- The user inputs data by speaking into a microphone.
- A few systems cant satisfactory perform this task because of:-
  i) Words with similar sounds.
  ii) Different people pronounce same words differently.
  iii) One word has multiple meanings.
  iv) Background noise etc.
- Computers that can recognize and properly read human voice will make information systems and other computerized applications accessible to people who can't enter data in the normal way i.e. blind, handicapped etc.

D. VOICE SYNTHESIS:

- These are machines that are able to create human voice or talk e.g. a computerized bank teller giving you your account balance in human like voice.

E. COMPUTER VISION:

- Scientists hope to develop computers that will process and interpret light waves just as the human brain does.
- Such systems would use scanning devices to sense and interpret objects, graphics and text character shapes.
- It will allow a computer to see as humans do, read and interpret text in almost any format.

F. ARTFIFICIAL NEURAL NETWORKS:

- The use of electronic devices and software to emulate the neurological structure of the human brain.
- The human brain works by receiving signals from special sensory cells called neurons.
- When the neurons receive information, they either excite the cell to send a signal to the brain or not.
- Artificial neurodes in artificial networks work in similar manner by perceiving environmental stimuli and hence deciding whether to pass it on to the system or not.
- The essential attributes of an artificial neural networks are:
  i) The neurodes can be trained to distinguish between what constitutes a signal and what does not.

  ii) They are capable of recognizing patterns in large amounts of data that are too complex for the human brain. From these patterns, they can make predictions and point out anomalies.

EXAMPLE:

In banking, the pattern of credit card usage can be tracked over time to try and generalize spending patterns of individual card owners. Incase of loss or theft, the bank can notice the change of spending pattern and conclude that the card is in the wrong hands, hence take appropriate security measures even before loss of the card is reported.

G. ROBOTICS/PERCEPTION SYSTEMS:

- A robot is a computer controlled device that emulates a human being in carrying out tasks that would otherwise be dangerous and difficult.
- Perception systems are sensing devices that emulate the 5 common sense of a human being i.e. sight, hearing, touch, smell and taste.
- Such devices would operate under the control of a microprocessor.
- This development would give robots artificial senses including:

i) Feeling the shape of an object.

ii) Listening to ultra sound.

iii) Detecting smell of leaking gas/chemicals.

iv) Testing quality of food.

v) Seeing using two miniature video cameras.

ADVANTAGES OF ROBOTS
1. They can work 24/7 all year round without getting bored or taking a break.
2. They can work faster than human.
3. Productivity is very high.
4. The output is of a consistently high quality.
5. They can work to great degrees of accuracy than human workers.
6. They can work in conditions that would appear hostile or dangerous to humans.

DISADVANTAGES OF ROBOTS:
1. They are expensive to build, install and maintain.
2. Not flexible as they are designed to do one job.
3. The robot may malfunction and cause a lot of chaos or a batch of faulty goods.
4. They take up the job of many people, leading to being sacked.
5. Evil people may use robots in war to manipulate biological material.

THE LAWS OF ROBOTICS:
1. A robot must not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must always obey orders given to it by a human being, except where it would conflict with the 1st law.
3. A robot must protect its own existence, except where it would conflict with the 1st and 2nd law.

EXPANDED INFORMATION SUPERHIGHWAY
- Involves the integration of cabled and wireless technologies for the purpose of data and information transmission.
- There is vast increase in throughput of various transmission media like fiber optic and wireless technologies.

- Scientists have demonstrated a fiber optic cable whose diameter is the size of a single strand of hair which is capable of carrying a trillion bit per second.
- Internet is growing tremendously causing what is generally referred to as a growth of the information superhighway to digital explosion or hurricane.

CAREER OPPORTUNITIES IN INFORMATION COMMUNICATION TECHNOLOGY (ICT)

ICT has created new job titles. Some of the computer career opportunities include:

1. SYSTEM ANALYST:
Responsible for analyzing a company's needs or problems then design and develop a computer based information system.

QUALITIES OF A GOOD SYSTEM ANALYST:
a) Should have good problem solving skills and creativity i.e. must have wide experience in solving problems.
b) Should have good communication skills i.e. be able to communicate clearly and precisely to different groups.
c) MUST have business knowledge i.e. understand the environment for which the system is being developed.
d) Must have technical knowledge i.e. well trained in relevant areas of computer science.
e) Must have general knowledge of the firm including its goals and objectives.
f) Should have knowledge of data processing methods and current hardware and familiarity with available programming language.

DUTIES OF A SYSTEM ANALYST:
a) Gather, record and analyze facts of the system.
b) Design new system and recommend changes to existing systems.
c) Prepare instruction manuals.
d) Co-ordinates training for users of new systems.
e) Work with programmers to construct and test the system.
f) Prepares system specifications.
g) Co-ordinates the implementation of new or modified system.

2. CHIEF PROGRAMMER/PROGRAMMING MANAGER:

Reports to data processing manager what has been reported by programming group, junior and senior programmers.

DUTIES OF CHIEF PROGRAMMERS;
a) Managing the programmers.
b) Liaising with the system analyst.
c) Review and control program documentation.
d) Reviews program's performance.
e) Ensures that all programs are well tested before put into use.
f) Reviewing all the system specifications before handover to programmers.

3. COMPUTER PROGRAMMERS:
These are people whose work entails coding i.e. formulating instructions for the computer to solve given problems.

QUALITIES OF PROGRAMMERS:
a) Good command of programming language in use.
b) Knowledge of general programming methodology and relationship between programs and hardware.
c) Creativity for developing new problem solving methods.
d) Patience and persistence.

DUTIES OF PROGRAMMERS:
a) Coding computer program using appropriate programming language.
b) Testing of programs for logical errors, syntax and semantic errors.
c) Debugging of programs.
d) Documenting programs i.e. writing manuals.
e) Designing and implementing programs.
f) Maintaining and reviewing existing computer programs.

4. DATABASE ADMINISTRATOR:
A person responsible for the design and implementation of the database.
The major purpose of computerizing an organization or institution is to store data in an organized way for easy access, retrieval and update.

DUTIES:

a) Responsible for the design and control of organization database.
b) Controls and monitors database usage through assignment of user passwords.
c) Keeping the database up-to-date by adding new records, or deleting unnecessary records.
d) Establishing the appropriate content and format of data records.

5. SOFTWARE ENGINEER:

Person skilled in software development and technical operation of computer hardware.

DUTIES:

a) Developing system and application software.
b) Developing user and technical documentation for the new software.
c) Maintaining and updating the software to meet day-to-day requirements.

6. COMPUTER ENGINEER:

Specialized personnel whose duties are to assemble the computer systems.

DUTIES:

a) Design and develop computer components e.g. motherboards, storage devices etc.
b) Design and develop engineering and manufacturing computer controlled devices such as robots.
c) Re-engineer computer components to enhance its functionality and efficiency.

7. WEB DESIGNERS:

They design website using various software tools. These webs contain pages where individuals and organizations can advertise themselves when promoting the products.

8. WEB ADMINISTRATORS:

They administrate the organization's websites by making sure the website is updated periodically to give the right information.

DUTIES:
a) Developing and testing websites.
b) Monitoring the access and use of internet connection by enforcing security measurers.
c) Downloading information needed by an organization from internet website.
d) Maintaining, updating and modifying information on the website.

9. COMPUTER OPERATOR:

This is a person who interfaces the user demands to the computer hardware by use of a set of special instructions known as commands.

DUTIES:
a) Entering data into the computer for processing.
b) Keeping up-to-date records of all information processing activities.
c) Responsible for the general equipment layout within the computer room.
d) Activating the computer to obey programs through use of commands.
e) Mounting the storage media e.g. disk to their drives.

10. COMPUTER TECHNICIAN:

These are members of the technical staff whose job is to service and repair computers.
Given that computers require regular maintenance, upgrading as well as emergency repairs, demand for computer technicians continues to grow as more people computerize their workplaces and homes.

DUTIES:
a) Troubleshooting computer hardware and software related problems.
b) Ensuring that all computer related accessories such as printers, storage media etc are in good condition.
c) Assembling and upgrading computers and their components.
d) Help hardware engineers in designing and creating some computer components such as storage devices, motherboards etc.

11. DATA PROCESSING MANAGER:

This is the person in the data processing department within the organization whose major duty is to ensure that the organization's needs are met.

DUTIES AND RESPONSIBILITIES:

a) In charge of data and information flow within the department.
b) Responsible in data collection and preparation.
c) Purchase of hardware and other facilities and their management.
d) Software development and maintenance.
e) Assessment and evaluation of staff performance.

12. INFORMATION SYSTEM MANAGER:

This person controls, plans, staffs, schedules and monitors all the activities of the ICT department in the organization. Using computerized management information system (MIS), the manager can test the impact that an alternative course of action might have on business.

RESPONSIBILITIES:

a) Making sure that all tasks in the IT department are done correctly and on time.
b) Preparing budgets for the departments.
c) Keeping the department inventory records up-to-date.
d) Managing the human resource within the department.

13. COMPUTER TRAINER:

Specialized personnel in the field of computing and well conversant with various disciplines and computer related issues which they can execute with ease.

RESPONSIBILITIES:

a) Training people on how to use computers and various application programs.
b) Developing training reference materials.
c) Guide learners on how to acquire knowledge through carrying out research.

d) Advising the learners on the best career opportunities in the broad field of ICT.
e) Preparing learners for ICT examinations.

14. NETWORK ADMINISTRATOR:
a) Specialist who oversees the smooth running of network system in an organization.

RESPONSIBILITIES:
a) Setup computer network.
b) Maintain and enforce security measures on network.
c) Monitor the use of network resources.
d) Maintain and troubleshoot network related problems.

15. COMPUTER TYPESETTERS:
Graphic designers and typesetters are required in order to design graphical objects and professional publications e.g. books, newspapers and magazines.

16. LIBRARIAN:
Responsible for keeping the files in various storage devices and for the physical security of the storage media.

DUTIES:
a) Ensures that there are enough physical files available for use.
b) Maintains the external files labels.
c) Ensures duplicates files are kept.
d) Ensures access of files is restricted to authorized persons.

17. SELF EMPLOYMENT:
This can be achieved by using a computer or other ICT devices such as mobile phones to start bureau services, internet services, consultancy services and computer hardware and software vendor business.

18. COMPUTER SALES REPRESENTATIVES:

Should have good knowledge in information ands communication technology. This would help them to analyze customer needs and advice them accordingly. A good computer salesman needs to be self confident, persuasive and proficient in business communication.

FURTHER EDUCATIONAL OPPORTUNITIES IN ICT

There are other tertiary institutions in computing where one would further his or her educational ambitions. They include:

1. Universities.
2. Polytechnics.
3. Middle level colleges.

1. UNIVERSITIES:

- Considered as the highest institution in formal education.
- They are categorized into two major groups i.e. public and private universities.

a) Public Universities:

- Established by the state.
- Run by a state appointed management.
- Admission to such universities is controlled by either the state or a recognized body.

Examples:

i. Jomo Kenyatta university of Agriculture and technology.
ii. Kenyatta University.
iii. Nairobi University.
iv. Maseno University.
v. Moi University.
vi. Egerton University.
vii. Masinde Muliro University of Science and Technology.

b) Private Universities:

- Self-sponsored institutions set up by individuals, churches or any other organization.
- They are privately run.

- Students' enrolment depends on whether the student is capable of sponsoring himself/herself.
- For them to operate, they must be registered or accredited by the commission of higher education or any other quality assurance body that is recognized worldwide.
- Accreditation leads to public acceptance and confirmation evidenced by the grant of charters by the state or accrediting bodies.

Examples:
   i. Daystar University.
   ii. Catholic University of Nazareth.
   iii. Mount Kenya University.
   iv. Kabarak university.
   v. Baraton University.
   vi. Catholic University of East Africa.
   vii.   Kenya Methodist University

Universities are authorized to offer approved Diploma, Undergraduate and Post graduate programmes.

ICT RELATED DEGREE PROGRAMMES
   i. Bachelor of computer science.
   ii. Bachelor of Information technology.
   iii. Bachelor of Science in Computer Engineering.
   iv. Bachelor of Science (Computer Networking).
   v. Bachelor of Science (Software Engineering).
   vi. Bachelor of Business and Information Technology.
   vii.   Bachelor of Science (computer programming).

ICT RELATED MASTERS PROGRAMS:
   i. Masters in computer science.
   ii. Masters in information technology.
   iii. Masters in hardware engineering.
   iv. Masters in science (computer engineering).

2. RESEARCH INSTITUTIONS:

- These are the other specialized research institutions that concentrate on narrow fields of study such as computer or ICT technology, agriculture, space science etc.
- It is possible to enroll in such institutions as a research trainee.

3. POLYTECHNIQUES:

- These are institutions of higher learning that mostly offer Diploma and certificate courses in technical fields such as ICT, mechanics, food production etc.
- A polytechnic may also be accredited by a university or the state to offer degree programmes.

EXAMPLES OF POLYTECHNICS THAT OFFER ICT IN KENYA:

i. Mombasa polytechnic.
ii. Kenya polytechnic.
iii. Eldoret polytechnic.
iv. Kisumu polytechnic.

ICT COURSES OFFERED IN POLYTECHNICS:

i. Computer repair and assembly.
ii. Computer operator.
iii. Management information system.
iv. Computer programming.
v. Computer networking.
vi. Computer software engineer.
vii. Computer studies.
viii. Information technology.
ix. Computer science.
x. Computer hardware engineer.
xi. Web administrator

4. COLLEGES:

- These are middle level institutions that offer diploma, certificates and craft courses in many disciplines such as technical, ICT, teacher training, business management etc.

EXAMPLES OF COLLEGES:

a) Rift valley Institute of Science and Technology.

b) Kaiboi Technical Training Institute.
c) Thika Institute of Science and Technology.
d) Kiambu Institute of Science and Technology.
e) Coast Institute of Science and Technology.
f) Kirinyaga Technical Training Institute.
g) Nairobi Technical Training Institute.
h) Nyeri Technical Training Institute.
i) Kenya Technical Training Institute.
j) Kenya Science Teachers College.
k) Machakos Technical Training Institute.

The most important considerations to make before you join a college to pursue an ICT course:
a) Whether it offers ICT courses recognized both locally and internationally.
b) The cost of training with such an institution.

EXAMINATIONS BODIES FOR HIGHER DIPLOMA, DIPLOMA AND CERTIFICATES:
a) Information Technology Standards Association (ITSA)
b) Institute of Management Information Systems (IMIS)
c) Kenya National Examinations Council (KNEC).
d) PITMAN.

QUALIFICATIONS GAINED ON STUDY ON SITTING FOR AN EXAM:
  i. Diploma in computer studies.
 ii. Diploma in computer science.
iii. Higher diploma in computer studies.
 iv. Higher diploma in information technology.
  v. Certificate in computer studies.
 vi. Certificate in information technology.